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**Te Reo Tātai: The Development of a Mathematics Register
for Māori-Medium Schooling**

A thesis
submitted in fulfilment
of the requirements for the degree
of
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Abstract

This thesis investigates the development of a lexicon and register to facilitate the teaching of mathematics in the medium of *te reo Māori*. This sociolinguistic development is situated within the wider Māori language revitalisation movement in Aotearoa/New Zealand, of which Māori-medium education is a central component.

Lexication of a language is a subdomain of corpus planning. Corpus, status and language-in-education planning are considered the three major interconnected domains of language planning and policy (LPP). For decades, the primary focus of LPP research has been on the activities of states and their agencies at the macro (national) level. The significance of this study is that it addresses this gap in the research, by investigating the development of LPP at the meso/micro-level—in this case, with respect to the development of a mathematics register for an endangered indigenous language, *te reo Māori*.

The thesis draws on two major participant data sources. The first is the narratives of key individuals at the forefront of lexical development for Māori-medium mathematics who recounted their experiences. The second is interviews with principals and teachers from two Māori-medium case study schools to examine their own learning and usage of the standardised *pāngarau* lexicon.

Two complementary theoretical frameworks were used to investigate the topic. First, an LPP theoretical framework was applied to investigate the complex relationships between the various levels of LPP that have impacted on the evolution of *te reo Māori* and Māori-medium schooling. Second, a linguistic framework, systemic functional linguistics (SFL), was used to investigate the linguistic and pedagogical issues.

Thesis findings show that the status of *te reo Māori* was variously affected by linguistic ideologies such as assimilation, which in turn led to such policies as English only in schooling. As a consequence, at the micro-level of LPP, Māori-medium mathematics development went into a hiatus for

over 100 years, and at the macro-level, considerable language shift occurred to English, causing *te reo Māori* to become endangered.

In response to language revitalisation efforts, the (re) vernacularisation of *te reo Māori* over the past 30 years has exhibited a complex combination of both bottom-up and top-down LPP. Within this, early *pāngarau* lexical developments were largely driven by local schools and their communities, which sometimes centred on the maintenance of their tribal dialects, often in conflict with later LPP agency language goals.

Subsequently, lexication for *pāngarau* was influenced by macro-level sociolinguistic beliefs such as linguistic purism, which in turn have influenced the technical approach to creating terms and may have created particular pedagogical issues, such as a lack of intertranslatability between *te reo Māori* and English at the higher levels of mathematics study.

While Māori-medium schooling has contributed significantly to language revitalisation in the past 30 years, its development has been very ad hoc. In the absence of a “formal” language plan for Māori-medium education, policy has been significantly driven by national education (English-medium) imperatives since the late 1970s to the present day. On the other hand, these policies have favoured mathematics education and directly supported the development of the Māori-medium specialised lexicon and register.

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Te Reo Māori (Māori Language) in This Thesis

As this thesis is based on the development of a Māori language phenomenon and involves Māori-medium education, the Māori language (*te reo Māori*) term is treated as the norm. The key *te reo Māori* terms are italicised with the English-language translation following in brackets when the term first occurs and from time to time thereafter. *Te reo Māori* terms used often also appear in the glossary below to help the reader who may not understand *te reo Māori*. Translations are my own unless otherwise noted, with Williams (1975b) being treated as the definitive reference and Te Taura Whiri i te Reo Māori (The Māori Language Commission) as the authority for the modern Māori language orthographic conventions (Te Taura Whiri i te Reo Māori, 2009). Macrons (horizontal bars) are used on *te reo Māori* terms as per Te Taura Whiri conventions, even when they appear in English-language text. Macrons are used in written Māori to indicate the correct pronunciation of the vowel, which has a lengthened sound.

Another key textual practice is the use of “Aotearoa/NZ” to refer to New Zealand. Aotearoa is the common Māori-language term for New Zealand, particularly the North Island. The term “New Zealand” is maintained when used as a proper noun, such as the name of a policy. Following is the glossary of terms. Many of the terms have multiple meanings in everyday *te reo Māori*. The translations provided here are the relevant meanings referred to in this thesis.

Māori term	Meaning in the context of this study
Aotearoa	Traditionally used for the North Island only, but now referred to as New Zealand
hapū	subtribe
hau	fraction in mathematics
iwi	tribe
kaumātua	elder
kaupapa Māori	Māori principles
kōhanga reo	Māori-medium preschool (language nest)
kupu	word
kura	school—generally referring to schools for Years 1 to 13
kura-a-iwi	Māori-medium school based on tribal language/region
kura kaupapa Māori	Māori-medium school based on Māori principles (Te Aho Matua), usually primary/elementary school level
mahere tau	number framework (basis of the number strand)
mana	prestige, authority
Māori	indigenous people of Aotearoa/NZ
mātauranga	knowledge/education
maramataka	calendar
marautanga	curriculum
mauri	spirit
Ngā Whanaketanga	Māori-medium national standards
Pākehā	European New Zealand (of white settler ancestry)
pāngarau	Māori-medium mathematics
pūtaiao	science
rautaki	strategy
reo	word, language
tangata whenua	person/people of the land
tango	subtract
taonga	treasure
tātai	old word for calculate
tatau (kaute)	count
tauanga	statistics
taurua	even number
tauirā	pattern, student
taurangi	algebra
taurea	multiple
Te Aho Matua	kura kaupapa Māori policy
Te Puni Kōkiri	Ministry of Māori Development
te reo Māori	the Māori language
Te Tāhuhu o te Mātauranga	The Ministry of Education
Te Tiriti o Waitangi	The Treaty of Waitangi
tikanga	custom
wairua	spirit
whakapapa	genealogy
whakarea	multiply
whānau	family
wharekura	Māori-medium secondary school

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Chapter 1. Introduction

The research aim of this thesis was to investigate the factors that have impacted on the development of the *pāngarau* lexicon and register for Māori-medium schooling, and the resulting sociolinguistic and pedagogical issues. Drawing on Halliday's (1978) systemic functional linguistics (SFL), register is defined here as the set of meanings (i.e., specialised terminology) that is appropriate to a particular function of language (see Chapter 3 for further discussion). It is important to note that, while both the lexicon and the register are presented throughout this thesis as though they could be two separate constructs, the register, in fact, comprises the lexicon. However, the primary language planning activity for Māori-medium schooling in Aotearoa/NZ has been lexicon (corpus) development, hence the focus on this component of the mathematics register (see Chapter 3 for discussion on the register).

The development of the mathematics register in *te reo Māori* discussed here has involved not just the development of the lexicon but also new ways of expressing meaning (Halliday, 1978). Ironically, this may have led to unplanned *te reo Māori* change, when one of the goals of reversing the significant language shift to English was the preservation of the indigenous language. Consequently, the thesis also investigates the possible negative effects of the establishment of linguistic norms to teach mathematics on *te reo Māori* and Māori culture. This does not suggest that mathematics is solely responsible for these potential negative effects on the language and culture; there are many other possible variables to consider, such as the influence of other curriculum areas and the fact that, in many homes, parents are second-language (L2) learners of *te reo Māori* and/or monolingual speakers of English.

This thesis investigates the issues associated with the development of a register in an indigenous language to teach mathematics within the broader socio-political context in which it is situated.

1.1 Background

This introductory chapter provides a brief introduction to the story of the development of a lexicon and register to support the teaching of Māori-medium mathematics, as a key language revitalisation initiative. In countries such as Aotearoa/NZ, the revitalisation and elaborating of indigenous languages are rarely universally supported. This introductory chapter provides a rationale as to why revitalising endangered indigenous languages such as *te reo Māori* should be supported, and introduces Māori-medium schooling, one of the grassroots initiatives central to supporting the revitalisation of *te reo Māori*.

The following two sections provide a brief background to the development, and eventual merging, of two distinct entities at the heart of this thesis: mathematics and *te reo Māori*.

1.2 Mathematics

The conventional account of Western mathematics is that it arose in Greek times, developed further in the Arab Empire in the Dark Ages and came to fruition in Europe during the Renaissance (Kline, 1972). From Europe, Western mathematics (primarily arithmetic and measurement in the early colonial period) eventually reached the shores of Aotearoa/NZ, brought by the various colonising missions of the early 19th century. Arithmetic is just one branch of mathematics—namely, basic techniques of calculation with numbers. Mathematics is much broader, including topics such as algebra, and it has evolved to being called mathematics and statistics in the schooling context in Aotearoa/NZ. As part of its evolution over many hundreds of years, Western mathematics has also developed unique philosophies and linguistic features (the mathematics register) to express a range of knowledge systems (Halliday, 1978).

Limited mathematics (generally arithmetic) terminology development (lexication) took place during the early contact period between Māori and *Pākehā* (non-Māori, referring to European settler people) in Aotearoa/NZ, to enable practices such as trade (see Chapter 6). However, most of the development of *te reo Māori* mathematics lexicon and register has occurred only in the past three decades (see Chapter 7). The creation of a

standardised corpus of terms and the development of a modernised mathematics register has its linguistic, cultural and political consequences—both for language communities and for the language itself.

The tensions and issues associated with the development of the lexicon can be exemplified in the following abbreviated story of the creation of a *te reo Māori* term for “mathematics” itself.

1.2.1 The story of the term *pāngarau*

In the 1980s, schools initially used a variety of terms to denote mathematics, including some historical terms dating back to the 1800s, such as *mahi whika* (working with numbers), *te kaute* (counting/calculating), *te mahi nama* (working with number). All these terms were transliterations from English, reflecting the era when borrowing a word from another language was an acceptable strategy to introduce new terms into *te reo Māori*, while also reflecting a delimited understanding of mathematics that was initially confined to working with numbers (arithmetic). However, these early mathematical terms were not acceptable to many in the modern era of lexicon development in *te reo Māori*. By the late 1980s, non-transliterated alternatives were being promulgated, including terms such as *mahi tau* (working with numbers) and *mahi tātai* (*tātai*, the old Māori term for calculate + *mahi*, work; Barton, Fairhall, & Trinick, 1995). In an effort to develop a more contemporary term that reflected the broader meaning of mathematics, the term *pāngarau* was casually suggested in a meeting in late 1990 in Rotorua between Te Taura Whiri i te Reo Māori (The Māori Language Commission) and a group of mathematics educators (who are called Te Ohu Pāngarau later on in this thesis) who had taken on the responsibility of standardising the terms. Somewhat to the surprise of some, the term was accepted by the group as the term for mathematics (Barton, Fairhall, & Trinick, 1995). Despite some resistance from the sector (primarily because they did not know its origin), the term *pāngarau* very quickly gained wide circulation and currency, including in official state documents, illustrating the power of print and government agencies in the standardisation of a language. The term *pāngarau* means multiple

relationships, *pānga* (relationship) + *rau* (multiple), and thus reflects a broader sense of what constitutes mathematics. The term *pāngarau* is now used almost universally as the term to denote mathematics in Māori-medium education and, by extension, *te reo Māori* in the wider language community.

1.3 Te Reo Māori

These recent developments are situated within a much wider linguistic history. *Te reo Māori*, an Eastern Polynesian language, is the indigenous language of Aotearoa/NZ. The conventional history of the language is that it was brought to Aotearoa/NZ by Polynesian seafarers migrating, most likely, from the areas of Tahiti and southern Rarotonga (Harlow, 2005). *Te reo Māori* evolved over several hundred years in Aotearoa/NZ in isolation from other languages, with many adaptations made to the language in response to a temperate climate and an environment different from that of its tropical homelands (Harlow, 2005). New ideas came to be expressed by adding new connotations to existing words, and sometimes radically altering their inherited meanings (calquing). An example is the term *murū*—the use of this word to denote a process of restorative justice appears to be unique to Māori; however, the connotations of the proto-Polynesian form, *mulu* (wipe, rub, shed layers), are also retained in *te reo Māori* (Biggs, 2001).

Additionally, completely new terms (neologisms) were created. Among *te reo Māori* words that appear to have developed in the post-Polynesian, pre-European contact period are terms such as *tatau pounamu* (literally greenstone door), to denote a peace pact. Both the word *pounamu* and the metaphor are locally generated in Aotearoa (Biggs, 2001). *Pounamu* (greenstone) is not naturally found in the Pacific other than in the South Island of Aotearoa/NZ.

In the process of its evolution in Aotearoa/NZ, *te reo Māori* developed unique linguistic features, underpinning philosophies and knowledge systems about the local temperate environments, such as the use of localised *maramataka* (lunar planting and fishing calendars; see Roberts, Weko, & Clarke, 2006, for a discussion on the use of *maramataka*).

Unique linguistic features included the base system for counting (see Chapter 6). Regional variations or dialects developed over time due to the different village or island origins of the speakers and to the relative isolation of local tribal populations (Benton, 1991). Thankfully for corpus development efforts in the domain of schooling, and unlike other indigenous language contexts, the tribal dialects are mutually intelligible (apart from some lexical items) to fluent speakers of *te reo Māori* to this day (Bauer, 1993).

1.4 The Endangered Status of Indigenous Languages

In common with its sister languages throughout Polynesia, albeit somewhat later in the colonisation cycle than other countries such as Australia and North America, *te reo Māori* was eventually confronted with the languages and cultures of European explorers, missionaries and settlers, in the late 18th and early 19th centuries (Harlow, 2005). In the early 1800s, the first European missionaries—finding Māori had no written language—began to formulate with the support of Māori written *te reo Māori*, essentially to facilitate Christian religious study (Jones & Jenkins, 2011). By 1820, a standard orthography had been developed and *te reo Māori* became a written as well as an oral language (Bauer, 1993). Throughout the 19th century, *te reo Māori* was still the predominant language spoken in Aotearoa/NZ by Māori, and in many cases by Pākehā (Benton, 1991).

The health of *te reo Māori* was significantly compromised in the 20th century, with language loss accelerating after World War II (Benton, 1991). For example, in 1930, a survey of Māori children estimated that approximately 97% of them spoke only *te reo Māori* at home (May, 2005). Since the 1940s, however, there has been a massive shift from a relatively stable Māori/English diglossia towards English-language monolingualism. This is a result of a range of assimilationist education policies and demographic and social changes, including rapid and extensive urban migration after the Second World War, when Māori shifted from socially isolated Māori-speaking communities into English-language-dominated urban areas, and into English-language-only schooling systems and workplaces (Spolsky, 2005). Collectively, these external forces supported

linguistic assimilation by influencing Māori to develop negative beliefs and attitudes towards speaking and learning their own language. Consequently, by 1960, it was estimated that only 26% of Māori people spoke *te reo Māori* (May, 2012). After nearly two centuries of contact with European settlers, the Māori language was by this time recognised as an endangered language (Fishman, 1991), threatened with possible extinction (Spolsky, 2003).

Unfortunately, this situation is not unique to *te reo Māori*. The world's linguistic and cultural diversity is under assault by the external forces of industrialisation and globalisation (Krauss, 1992). These are the cultural, economic and political forces that work to standardise, homogenise and, in some cases, eliminate languages. These forces may include the development of nation states and state official language policies that support education in the colonial language and culture rather than in the local indigenous languages and traditions (Krauss, 1992). Language endangerment has also been caused by internal pressures, such as a community's negative attitude towards its own language (Crawford, 2007). Internal pressures often have their source in external ones, particularly the overtly negative perception of indigenous languages in wider society. The combination of internal and external pressures has halted or interrupted the intergenerational transmission of many indigenous linguistic and cultural traditions (UNESCO, 2003). These pressures have seriously threatened minority linguistic, cultural and educational rights for indigenous peoples worldwide.

Estimates vary as to the number of endangered languages worldwide, but various sources quote the figure at 50% of the languages spoken in the world (Krauss, 1992). Moreover, it is estimated that as many as half the estimated 6,900 languages spoken on earth are "moribund"; that is, they are spoken only by adults who no longer teach the language to the next generation (Frawley, 2003). It is estimated that 90% of existing languages today are thus likely to die or become seriously threatened within the next century (Lewis, 2009). It is a race against time for many indigenous people because they have nowhere to turn but to their own local communities to replenish the pool of heritage-language speakers (Sims, 2001).

The debate over the preservation of endangered indigenous languages has gained momentum in recent years, and is frequently situated in increasingly politicised discourses on whether indigenous languages should be saved or not (Koenig, 2002). Broadly, the arguments for saving indigenous languages can be grouped around a number of contested ideas. These include the argument that languages are the repositories of cultural knowledge about the world, built up over many thousands of years of observations and experience, and that this knowledge is of benefit to all humankind (Chrisp, 2005; Hale, 1992). Consequently, language loss can be viewed as an erosion or extinction of ideas, of ways of knowing and ways of talking about the world, and is a loss, not only for the community of speakers itself, but for human knowledge generally (Harrison, 2007). Noted linguist Wurm (1991) had this perspective on what is lost when a language “dies”:

Every language reflects a unique world view and culture complex, mirroring the manner in which the speech community has resolved its problems in dealing with the world . . . With the death of the language . . . an irreplaceable unit of our knowledge and understanding of human thought and world view has been lost forever. (p. 17)

A contentious issue in linguistic research is the proposition that each language embodies a world view, with different languages embodying different views, so that speakers of different languages think about the world in different ways (Harrison, 2007). This viewpoint is sometimes called the Sapir-Whorf hypothesis after the early 20th-century linguist Edward Sapir and his student, Benjamin Whorf, who made it famous (see Gumperz & Levinson, 1996, for a sampling of literature on the Sapir-Whorf hypothesis). Chandler (2004) suggested that although there are few modern proponents of Sapir’s and Whorf’s ideas of “linguistic determinism” in their strongest form, many linguists have accepted a more moderate, or limited “Whorfianism”; namely, that the ways in which we see the world may be influenced by the kind of language we use.

It is also argued that languages hold a group’s cultural history (Crystal, 2003b). The cultural history may consist of prayers, stories, ceremonies, poetry, oratory and technical vocabulary as well as everyday greetings, leave takings, conversational styles, humour, ways of speaking to children

and terms for habits, behaviours and emotions (Crystal, 2003b). Crystal (2003b) contends that when a language is lost, all of this must be refashioned in the new language, with different words, sounds and grammar, if it is to be kept at all. He supports the view that languages should be maintained because a people's history is passed down through its language, so when the language disappears it may take with it important information about the early history of the community (Crystal, 2003b). Nettle and Romaine (2000) also specifically support the maintenance of languages, because:

Every language is a living museum, a monument to every culture it has been a vehicle to. It is a loss to every one of us if a fraction of that diversity disappears when there is something that can have been done to prevent it. (p. 14)

Fishman (1991) noted that, traditionally, the primary argument for language maintenance in sociolinguistic work is that culture and language "stand for each other" (p. 22). It is argued that languages are a fundamental part of a people's culture (Lemke, 1990). They relate to local customs, beliefs, rituals and the whole display of personal behaviours (Crystal, 2003b). Fishman (1991) also presented the idea that most of the culture is in the language and is expressed in the language. He further added that "take language away from the culture, and the culture loses its literature, its songs, its wisdom, ways of expressing kinships relations and so on" (Fishman, 1991, p. 72). Crystal (2000) linked language to the issue of identity: "if we want to make sense of a community's identity, we need to look at its language" (p. 39). Therefore, when a community loses its language, it often loses a great deal of its cultural identity.

The next argument is probably not as contentious: that is, the whole thrust of modern linguistics is to determine just what language is: where it came from, how we acquire it, how it works, how it relates to cognition (Bickerton, 2009). Therefore, the wholesale loss of languages will greatly restrict how much we can learn about human cognition, language and language acquisition (Marques, Pérez de la Blanca & Pina, 2005). For example, linguists' assumptions about language have been challenged by research, including the discovery of different linguistic structures in

different languages (Harrison, 2007). To advance their science, linguists need data that can only come from speakers of languages.

More fundamentally, language loss and revitalisation are human rights issues, connected to issues of power relations that underpin language loss (May, 2005). The loss of a language reflects the exercise of power by the dominant over the disenfranchised, and is concretely experienced “in the concomitant destruction of intimacy, family and community” (Fishman, 1991, p. 4). The vast majority of today’s threatened languages are thus, not surprisingly, spoken by the socially and politically marginalised (May, 2005). Indigenous groups are frequently asked to pay the entire price of accommodating linguistic change, often on spurious grounds (Crystal, 2003b). For example, there is a misconception held by some that the indigenous language community will have better access to the economy if they abandon their indigenous language and learn the dominant group language, such as English (May, 2005). History has shown often that this is not the case. In many countries, including Aotearoa/NZ, indigenous groups are still at the bottom in regard to health statistics, education and wealth (see Statistics New Zealand, 2014, for the latest Māori health statistics at the time of writing this thesis).

The arguments above apply to and resonate with Māori who are striving to revitalise their endangered language, *te reo Māori*. *Te reo Māori* is the one language grounded completely in Aotearoa/NZ—its land, landscape, flora, fauna and the history and experience of its human discoverers (Benton, 1984). There is a great body of Māori history, *waiata* (song), *kīwaha* (colloquial language) and *whakataukī* (proverbs) that depend on the language. If the language dies, all of that too will die and the culture of many hundreds of years will ultimately fade into oblivion (Waitangi Tribunal, 1986). Harlow (1991) also raised the importance of language to identity, suggesting that a people without its own language has no power or unique identity. Sentiments about the importance of *te reo Māori* to Māori are encapsulated in this much-cited quotation from Sir James Henare (Waitangi Tribunal, 1986):

The language is the core of our Māori culture and mana. *Ko te reo te mauri o te mana Māori* (The language is the life force of the mana

Māori). If the language dies, as some predict, what do we have left to us? Then, I ask our own people who are we? (p. 53)

Additionally, Durie (1997) argued that Māori initiatives aimed at language recovery are instrumental efforts not merely to revive a language for day-to-day communication, but more importantly, to fulfil psychological needs central to the wellbeing of Māori individuals and groups.

Te reo Māori is the language of the indigenous group of Aotearoa/NZ, a people who have no significant *te reo Māori*-speaking population base anywhere else in the world. If *te reo Māori* is no longer to be spoken in Aotearoa/NZ, Māori people will lose one of their *taonga* (treasures)—the vehicle of their culture (Waite, 1992). For Māori, the revival and then ongoing maintenance of *te reo Māori* is a critical language planning goal in itself.

1.5 The Revitalisation of *te Reo Māori*

In the wider political context, the change in status affecting the Māori language galvanised groups in the late 1970s to demand greater use of *te reo Māori* in the government and other public institutions controlled by the government, most notably, education (Walker, 1996). Eventually, the state was compelled to respond, and put in place policies to address the low status of *te reo Māori*. Concurrent with macro-level changes in the status of *te reo Māori* at the national level were a wave of grassroots initiatives to ensure the survival of *te reo Māori* (Reedy, 2000). One of the most important of these grassroots community initiatives was the development of bilingual education schooling, which eventually evolved into Māori-medium schooling (see Section 5.4.1 for discussion on the contested definitions of bilingual education in the Aotearoa/NZ context).

1.5.1 The evolution of bilingual and Māori-medium schooling

The developmental trajectory of the modernised Māori-medium mathematics register is a component (albeit one narrow strand) of the revitalisation of *te reo Māori* in schooling. It can be traced back to the emergence of the bilingual education movement in the late 1970s, the development of *kōhanga reo* (Māori-medium early childhood education) in the early 1980s, and the subsequent evolution of *kura kaupapa Māori*

(Māori-medium schooling option that follows a specific language and education policy: *Te Aho Matua*¹) and Māori-medium schooling options in the compulsory schooling sector in the mid-1980s and 1990s (see Section 6.4.1 for further discussion).

Collectively, all the various forms of Māori-medium schooling have been required to teach New Zealand state-mandated school subjects, including mathematics. Even if not compelled to by the state, it is highly likely that a number, if not all, of these schools would have taught Māori-medium mathematics in one form or another. This is because mathematics is frequently a prerequisite for entry into higher education. All of the Aotearoa/NZ universities require NCEA credits at Level 1 as one of the criteria for entry for students under 20 and for a number of courses, irrespective of the age of the student (Te Pūkai Tara: Universities New Zealand, 2013). The development of the various schooling movements listed above provided the catalyst for the development of a new field in mathematics education in Aotearoa/NZ in the 1980s: Māori-medium mathematics.

1.5.2 Māori-medium mathematics

Māori-medium mathematics emerged as a field of study in its own right in the late 1980s. Questions were raised and continue to be raised about the role of traditional Māori mathematical practices (Riini & Riini, 1993), and their place in modern schooling (Meaney, Trinick, & Fairhall, 2012). Issues were also raised about student achievement (Aspin, 1995). Not surprisingly, language issues have remained a topic of discussion through the late 1990s (Barton, Fairhall, & Trinick, 1998) and up until now (Meaney et al., 2012). This thesis continues that trend.

Most of the literature highlighted above has been from the perspective of mathematics education. In contrast, this thesis addresses the paucity in current research of the issues to do with the development of the Māori-medium mathematics terminology and register itself, particularly from the perspective of the broader field of language planning and policy (LPP).

¹ *Te Aho Matua* is the foundation philosophical document for *kura kaupapa Māori*. It lays down the principles by which *kura kaupapa Māori* identify themselves as a unified group—see Smith (1990).

Language planning can be defined as any decision or action that affects language change, whatever the scale—such as the creation of new terms for Māori-medium mathematics (Kaplan & Baldauf, 1997). However, language planning has traditionally been thought of in terms of macro-level, large-scale, usually national planning, often undertaken by governments and meant to influence, if not change, ways of speaking or literacy practices within a society (Kaplan & Baldauf, 1997). There has been some discussion of, but little scholarly work on, the idea that LPP can (and does) occur at lower (meso- and micro-) levels (Baldauf, 2006). The significance of this thesis is that it situates the development of Māori-medium lexicon in meso- and micro-language planning, which, although much less studied, is significantly influenced by macro political and cultural influences (Kaplan & Baldauf, 2003).

Accordingly, this thesis investigates the connections between micro-, meso- and macro-language policy and practices in Aotearoa/NZ, including the various macro-linguistic ideologies and beliefs that historically supported assimilation, and, subsequently, the vernacularisation of *te reo Māori*, at the meso and micro-levels.

1.5.3 Pedagogical implications: Māori-medium mathematics register

A significant body of international research examining language issues in the learning of mathematics has identified that language use in school differs in some important general ways from language use outside of school. Moreover, subjects such as mathematics are characterised by specific registers that may impinge on student learning (Halliday, 1978; Halliday & Hasan, 1985). For example, features of the mathematics register, such as highly technical grammar, may prove challenging to learners (Veel, 1999).

Learning the mathematics register may be a prerequisite to understanding the specific content or to academic development in general (Cummins, 2000; Mousley & Marks, 1991; Pimm, 1987). It is argued that, perhaps more than any other subject, the construction of knowledge about mathematics depends on the oral language explanations and interactions of the teacher (Schleppegrell, 2007), especially when the medium of

instruction is the student's weaker academic language (Khisty & Chval, 2002).

Collectively, this research points to several key language considerations for Māori-medium mathematics education, particularly because it is a high-stakes and compulsory subject in the state system. Of prime concern is the contention that teachers and students require a functional grasp of the complex Māori-medium mathematics language, which includes the register.

1.6 Researcher Positioning

In many aspects, the story of *te reo Māori* lost and regained mirrors my own experience in education over the past 50 years, including 20 years or so as a Māori-medium mathematics educator. Therefore, I need to acknowledge my own position in this thesis. Not only am I the researcher and writer of this thesis, but I have also been an active participant in the Māori-medium mathematics development process for over 25 years—initially as a teacher, then as a curriculum and resource developer, and a provider of mathematics education support to Māori-medium schools, and finally, as a lecturer and researcher at the tertiary level in Māori-medium mathematics education. What follows is an outline of how my own personal history connects with the changing status of *te reo Māori* and the evolution of Māori-medium mathematics as a research discipline.

My story begins in Te Paripari (steep cliffs), a small, remote eastern Bay of Plenty rural settlement in New Zealand's North Island just east of Te Kaha, where I spent my early formative years. Te Paripari is typical of the many small *kāinga* (villages) dotted along a rugged narrow coastline in the Whānau-ā-Apanui tribal lands. *Te reo Māori* was spoken exclusively in the community up until at least the 1950s. By then, through intermarriage and the English-only schooling policy that the local native schools were required to follow, there had been some language shift to English in our community. During my childhood, Te Paripari, like all isolated rural settlements scattered along the coast, was predominantly made up of farmers, fishermen and World War II veterans and/or their widows.

At the time of writing, the tribe I belong to, Te Whānau-ā-Apanui, retains over 96% of its original tribal estate. This is unique in Aotearoa/NZ. By 2009, as a result of colonisation, which involved forced land sales and significant land confiscation, Māori land (as designated by the Māori Land Court) comprised less than 5% of all land in Aotearoa/NZ (Māori Land Court, 2012). While I am proud of my tribal heritage, I suggest the principal reason our tribe still owns most of its tribal estate, in contrast with the situation of other *iwi* (tribes), has a lot to do with its isolation and the inaccessible geographic nature of the narrow coastline, which lacked appeal for early European farmers and land speculators. Consequently, the permanent residents were almost exclusively from Te Whānau-ā-Apanui tribe. The exceptions were a few Pākehā (European) who had married into the *whānau* (family), temporary Pākehā school principals, a local policeman, shopkeepers, and holidaymakers who came to enjoy the unspoilt outdoors in summer.

I was raised by my maternal grandmother, Te Ataiti, which is a common practice in traditional rural Māori communities. English was her L2, and the only domain in which English was spoken during her formative years was at school; *te reo Māori* was the dominant language of her generation. When I grew up, our community was made up of the elderly and very young, many members of our community (including my mother) having migrated to urban centres seeking higher education opportunities and employment during the 1940s to 1960s, a typical migratory practice from the isolated rural areas of that time to towns and cities. Although our grandparents were native speakers of *te reo Māori* and spoke minimal English, they made a conscious effort to speak to us in English in the belief that this would help our English-language development and thus career options.

My grandmother was of the generation when schooling was “English only” and students were physically punished for speaking Māori at school (Simon, 1998). For many school graduates of my grandmother’s generation, the English-only policy of our local tribal schools left scars of shame and ambivalence about *te reo Māori*, leading them to socialise their children in English. There was consequently a significant language shift

from Māori to English from my grandmother's generation to my mother's and to mine. One of the reasons internal to the community was the perceived low status of *te reo Māori*. My grandfather had died young (aged 40), and my grandmother and her peers struggled financially on their small farms and perceived it an economic and educational advantage for us to learn English to enable us to seek careers elsewhere. This was reinforced by her experiences at school, where she and her peers, almost all of whom were close relatives, were actively and punitively discouraged from speaking their first language (L1). Instruction was entirely in the medium of English in the local primary schools at that time. Schools in the Whānau-ā-Apanui tribal district were set up under the 1867 Native Schools Act. This Act provided for the establishment of schools in Māori villages on the condition that the Māori community provided land and contributed to the cost of the buildings and teachers' salaries (see Simon, 1998, for further discussion on native schools). By the time my generation started school, although there was no formal English-only policy, there was tacit support for it, with our local primary school curriculum containing minimal Māori language and cultural content, despite a Māori student roll of over 90%. The subtractive view of bilingualism was very dominant in the education system and local community.

I subsequently attended the local Te Whānau-a-Apanui District High School, where, by the 1970s, *te reo Māori* had been introduced as an optional subject in the state secondary school system. As a consequence, we were exposed to significantly more Māori language and greater opportunities to learn our tribal traditions than in our formative years at primary/elementary school. Although English was our L1 and the language of schooling, most of the students came from Māori-speaking homes and *kāinga* (village) and, while not necessarily very proficient, could understand and converse in *te reo Māori*. It was while I was at high school that I came under the influence of two language and cultural revivalists: the late Wiremu (Bill) Tawhai (first Māori principal of the local high school) and the late Roka Paora. Both were to become key authorities and advisers on tribal land traditions and *te reo Māori* and *tikanga* (customs and traditions).

Unfortunately, Te Whānau-ā-Apanui District High School did not have a programme for students beyond Year 11 (Form 5, School Certificate), so those of us who aspired to further education were sent out of the district to boarding school—in my case, Gisborne Boys High School (GBHS). While at GBHS, I was recruited into teaching at Palmerston North Teachers College, essentially by the incentive of a weekly allowance. After graduating from the teachers college in 1977, I started my teaching career in Gisborne in 1978 at a local English-medium primary school. I was subsequently transferred to Auckland by the then Department of Education, teaching in a variety of English-medium intermediate schools until the end of 1981. Like many New Zealanders, I then travelled overseas to broaden my life experiences.

On my return to Aotearoa/NZ in 1983, I procured a teaching job at a secondary school in South Auckland, teaching mathematics and science in the medium of English. Here I came under the influence of *te reo Māori* language revivalists from my own tribal area, Te Kapa and Pani Stirling, who also influenced my future study and career. By this time, bilingual education had emerged in Aotearoa/NZ, initially in rural primary schools and subsequently in urban areas such as South Auckland, where there was by now a significant Māori population. As a consequence of the emergence of Māori language revitalisation efforts in schooling, groups of local teachers and mathematics educators (including myself) began meeting regularly to discuss the possibilities of adding Māori contexts and some Māori terminology to our mathematics programmes. There was no standardised list of mathematics terms at that time, and I was fortunate to have the support of the late Pani Stirling, a native speaker and teacher of *te reo Māori*, to help develop mathematics resources and to coin *te reo Māori* mathematics terms. This sort of activity at the local school level in the early 1980s, and the work of the Auckland group and similar groups around the country, led to the beginning of the standardisation of Māori-medium mathematics lexicon nationwide.

These developments drew me and a number of other teachers around Aotearoa/NZ into teaching mathematics bilingually in secondary schools (Ohia, Moloney, & Knight, 1989, 1990). However, in my case, it was not

initially out of concern for the perilous state of *te reo Māori*. I was concerned rather at the significant dropout rate (80%) of Māori students between Years 9 and 11, the first years of secondary schools, and we (the teaching staff) in our secondary school experimented with several initiatives to address the issue (see Smith, 1997, for parallel developments in *kaupapa Māori* education). These initiatives included creating Māori-student-only classes for poor attendees and for those who exhibited signs of dropping out of school. These classes were taught by a Māori mathematics teacher, the aim being to address the issues of cultural divide that existed between the students and many of their teachers.² In this instance, the initiative was not very effective at addressing the issue of student retention. Patterns of behaviour were already well entrenched, and despite good intentions, the retention rate was not significantly enhanced.

Subsequently, in the late 1980s, Māori teachers, with minimum support from senior management, trialled various approaches to increase the retention rate of Māori students. One such approach included the creation of a Year 9 “bilingual class” of students in which informal communication and some of the subject content would be delivered in *te reo Māori*—not just English, as was the previous practice. This was linked to the idea gaining momentum in the 1980s that, by strengthening the identity, language and culture of Māori learners in the education system, Māori students would be more likely to succeed (Bishop & Berryman, 2006). It was an opportune moment, because several curriculum specialists at the secondary school level, proficient in *te reo Māori*, had begun teaching at my school. It was therefore difficult for the senior management of the school to block this development on the grounds of a lack of teacher capacity. Many of these teachers were involved in the wider *te reo Māori* language revitalisation movement and saw this particular schooling initiative as a means to address two significant issues concurrently: Māori student retention and *te reo Māori* revitalisation.

It soon became clear that, despite the best of intentions, and significant improvements in student retention rates, the bilingual education model we

² See Bishop and Glynn (1999) for further discussion on the relationship between Māori students, culture and learning.

were practising was not developing student *te reo Māori* proficiency beyond a basic communicative level. Our efforts were not addressing the parlous state of the language to any significant degree. Subsequent to my departure, the school's bilingual model evolved to become a full immersion model (following the New Zealand approach to definitions of bilingual education; see May & Hill, 2005), maintaining continuity from primary to secondary levels. It is now considered one of the more successful Māori-medium schools in the country.

In the early 1990s, I moved out of teaching secondary school students into a curriculum advisory role, supporting teachers in secondary schools who had set up bilingual units to teach mathematics and science. This was during a period of tumultuous reforms of the New Zealand education administrative system, including major curriculum reforms, the rapid expansion of *kura kaupapa Māori* (see Chapter 6) and the emergence of Māori-medium initial teacher education in its various forms. In 1992, I was cajoled into leading the development of the first Māori-medium mathematics curriculum (McMurchy-Pilkington, 2004). This was a time of considerable political and social tension in the education system due to the introduction of the various ideologies that underpinned “Tomorrow’s Schools”,³ including ways of working that affected the nature of the curriculum reform process. However, my involvement did not appear to derail my career, and I was invited to become a part-time lecturer in several emerging Māori-medium initial teacher education programmes. I gained a permanent teaching position at the Auckland College of Education, which later merged with the University of Auckland, lecturing in *pāngarau* (Māori-medium mathematics) education from 1996 to the present. Simultaneously, I have worked on a range of local school and national Ministry of Education initiatives to support the development and implementation of *pāngarau* education in Māori-medium schools. These initiatives have included the revision of the *pāngarau* curriculum, the Poutama Tau Project (Māori-medium numeracy project), the development of *whanaketanga* (Māori-medium national standards) and the development

³ Tomorrow’s Schools is the term given to changes introduced in the administration of New Zealand education to devolve decision-making to the school community (Lange, 1988; Olssen & Mathews, 1997).

of mathematics standards for NCEA (for further discussion, see McMurphy-Pilkington, Trinick, & Meaney, 2013; Meaney et al., 2012).

1.7 Academic Rationale for this Study

This thesis approaches the development of Māori-medium mathematics (*pāngarau*) from a sociolinguistic perspective—namely, language planning. If one accepts that mathematical education research centres on attempts to understand how mathematics is created, taught and learnt most effectively, there are at least three major reasons why mathematics educators should pay attention to (socio) linguistic issues, particularly when the language concerned is an endangered indigenous language:

- i. Internationally, a number of indigenous groups are expanding and elaborating their indigenous languages to facilitate the teaching of Western mathematics, often in a struggle to simultaneously address wider language revitalisation efforts (Meaney et al., 2012). Such a development has implications for the indigenous language and culture. The significance of this study is that the findings will help groups involved directly and indirectly in the development process to know what these implications are. To make decisions about lexication and mathematical registers, indigenous groups need first to know what a mathematics register is (see Chapter 3 for discussion on definitions of the register), what its essential features are, and what features can be changed or omitted and why.
- ii. Traditionally, much of the research in LPP focused on the macro-level (Kaplan & Baldauf, 2003); however, there is an increasing interest in micro planning (Baldauf, 2006). In order for language planning (and policy) to be successful, particularly for language revitalisation, it needs to extend down through the system, including to the micro-level of schooling. However, the quantity of research focusing on the meso (institutional) and micro (community and or individual school; see Section 2.7) levels of LPP is light. This thesis helps contribute to the material available.
- iii. Although research on students who do not have the language of instruction as their L1 in mathematics classrooms has been an area of interest since the 1980s, there has been minimal research on the

issues faced by teachers. Yet, in the Aotearoa/NZ context, most teachers are teaching in a language that is not their L1, and in which many may not be fluent, in the Māori-medium schooling context (May & Hill, 2005; Rau, 2004). This is the result of the language loss of *te reo Māori*, discussed above, and obviously has significant pedagogical implications. Thus, the study of how teachers, many of whom are L2 learners, learn the specialised terms and register may improve our approaches to mathematics education in the medium of *te reo Māori* at the national policy and classroom levels.

As the above three points illustrate, this study is located in an area where research from two interrelated disciplines is useful. Education and sociolinguistics (in particular, LPP) have much in common. The processes of learning and communication are closely interrelated and are situated in fluid and evolving socio-political contexts. The histories of the two disciplines have common features. Traditionally, both utilised mostly quantitative, scientific methods and, in particular, statistically based research techniques to investigate research questions. Over time, critical theories have emerged in reaction to the limitations of the positivist paradigm and have sought to explain both mathematics education and LPP in light of the cultural, political, historical and economic influences that shape them. Sociolinguistic and education interests overlap. Researchers in the two disciplines are faced with similar methodological problems and thus have much to contribute to one another's discipline.

1.8 Research Question

The research question underpinning the investigation in this thesis is as follows:

What are the key factors (beliefs, policies and language ideologies) that have impacted on the development of the mathematics register for Māori-medium schooling and *te reo Māori* generally and the issues and tensions that have arisen as a result of this development?

1.9 Thesis Outline

As noted, Chapter 1 introduced the research topic and a rationale for the study. It provided a brief history of *te reo Māori* and an argument for its preservation including the role of Māori-medium schooling in its revitalisation.

Chapter 2 traces the development of LPP as a research discipline, and provides a theoretical and conceptual LPP framework to identify and critique the ideologies and beliefs that supported the linguistic assimilation and then (re) vernacularisation of *te reo Māori* in the modern era in later chapters.

Chapter 3 examines the evolution of SFL and theories of “register”. It includes an examination of the development of the mathematics register in English, multilingual and indigenous language contexts to provide a contrast to *te reo Māori*.

Chapter 4 draws on literature to examine the vitality of *te reo Māori* over the past 130 years using the theoretical LPP framework developed by Kaplan and Baldauf (1987) of status and corpus planning discussed in Chapter two to provide a historical context to the third dimension of LPP—*te reo Māori* in education.

Chapter 5 charts the rise of the bilingual schooling movement in the 1980s through to the emergence of the various *te reo Māori* immersion education models in the 1990s that collectively provided the catalyst for the substantial lexication work.

In Chapter 6, the philosophical assumptions underpinning the research methodology adopted in the thesis are introduced. In addition, the scope and limitations of the research design are defined and the methods of data collection and analysis are described.

Chapter 7 draws on the narrative by key informants to chronicle the story of the lexication of the *pāngarau* terminology, utilising the Kaplan and Baldauf (2003) LPP model of establishing norms of codification and elaboration.

The next chapter presents a case study of two Māori-medium schools that are models of LPP at the micro-level, and includes the results of interviews with principals and teachers on how the sociolinguistic norms in the form of standardised *pāngarau* terminology are being learnt and used by the teachers.

Chapter 9 discusses the sociolinguistic and pedagogical debates and issues that have emerged in the previous chapters as a consequence of modernising (elaborating) *te reo Māori*, including the development of a specialised register for teaching mathematics.

Chapter 10 discusses key findings, limitations of the research and conclusions. Areas where further research is needed are identified.

Chapter 2. Language Planning and Policy (LPP)

2.1 Introduction

This thesis situates the development of Māori-medium lexicon in meso- and micro-language planning, which, although much less studied, is significantly influenced by macro political and cultural influences (Kaplan & Baldauf, 2003) (see Section 2.7 for discussion on definitions of levels of LPP). Drawing on national and international LPP literature, this chapter presents a theoretical and conceptual sociolinguistic framework to investigate the research question. This theoretical framework has guided the identification and critique of the issues, beliefs and ideologies associated with the development of the *pāngarau* (mathematics in the medium of Māori) lexicon and register discussed in later chapters.

2.2 The Field of Sociolinguistics

The field that refers to the study of the relationship between language, a society and how the language is used is termed sociolinguistics (Holmes, 2001). Sociolinguists are interested in explaining why people speak differently in different social contexts and the effects of social factors (ethnicity, class, social status) on language varieties (dialects, registers, genres). According to Coulmas (2005), the central theme of sociolinguistics is linguistic *variety* and *choice*. The principal task of sociolinguistics is to uncover, describe and interpret political, cultural and social aspects that impinge on linguistic choice (Coulmas, 2005). The research discipline that examines the decision-making processes and the intervention and changes in the linguistic organisation of society is LPP (Kaplan & Baldauf, 1997). Thus, the field of LPP can be considered a component of the broader sociolinguistic field of study, and the two are interrelated.

The chapter examines the more general theoretical issues that have contributed to the historical development of LPP frameworks. While Kaplan and Baldauf (1997) suggested that language planning is not intended to be theory driven, but rather “responsive to real-world interdisciplinary solutions of immediate practical problems” (p. xi), it is useful for the purpose of this thesis to understand the ideas and beliefs

that underpin the evolution of LPP. Relevant literature that discusses the concept of LPP in more detail is explored as key writers contest the definition of “LPP” in sociolinguistics.

The chapter concludes with an examination of the various typologies (classifications/categories) and frameworks of language planning processes and activities that researchers have created or adapted in order to describe the field of LPP.

2.3 Theories of Language Planning

Internationally, the changes in language planning perspectives over the years have occurred as a result of dominant global events such as mass migration, imperialism and the formation of new states. In reaction to these changes, theories and agendas of LPP have evolved over time. According to researchers working in the area of language planning, such as Ricento (2000), there is actually no universally accepted theory of language policy and planning. In Ricento’s view, the language issues that lie at the base of language planning are too complex and intricately interwoven with other policy domains to be analysed through one paradigm; thus, it is impossible to constitute an overarching theory for the concept (Ricento, 2000). While not all researchers support this view, it does illustrate the contested discourse of LPP (Kaplan & Baldauf, 1997). The following section outlines the growth of this field of academic interest, including a number of key findings that have significantly influenced and shaped present-day language planning theory.

2.3.1 Historical development of language planning theory

Language planning activities have been going on for centuries around the world and can be considered as old as language itself (Wright, 2004). However, the emergence of LPP as a designated area of research is fairly recent, emerging in the early 1960s in response to solving language problems in new, developing and postcolonial nations. In a useful critique of the field of LPP for mathematics educators such as me, Ricento (2000) divided the evolution of LPP as an academic field into three broad stages of development, each stage spanning roughly two decades. He added: “three types of factors have been instrumental in shaping the field, that is,

in influencing the kinds of questions asked, methodologies adopted, and goals aspired to" (Ricento, 2000, p. 9). These factors are the macro socio-political events and processes, epistemological paradigms and wider LPP goals (Ricento, 2000). The following sections examine the literature that reflects these evolving theories of language planning, using the generalised eras of development as suggested by Ricento (2000) to frame the discussion.

2.3.2 Early work: Postcolonialism, structuralism and pragmatism (1960s–1970s)

The individual frequently credited with the creation of the term "language planning" is Haugen (1968), in his study of language standardisation in Norway (Tollefson, 2008). Various terms, such as "language engineering", had previously been used to refer more or less to the same activity (Karam, 1974, p. 104). In Haugen's (1968) seminal article, language planning was defined as an activity of preparing a normative orthography, grammar and dictionary for the guidance of writers and speakers in a non-homogenous speech community. What follows from Haugen's early definition is that language planning was seen as corpus planning only (see below).

During this early phase of LPP, many scholars were thus preoccupied with laws and regulations and planning issues concerned with how to codify and standardise the lexicon and syntax (corpus planning) associated with decolonisation and the language problems of newly independent states (Ferguson, 2006). Initially in the research, language planning was conceived as the responsibility of technical experts who had efficient standardisation techniques at their disposal, supposedly working objectively (Nekvapil, 2006). For example, Rubin and Jernudd (1971) suggested that language planning concentrated on the solutions to language problems "through decisions about alternative goals, means, and outcomes to solve these problems" (p. xvi).

Critiquing this early research work, Ricento (2000) and Kaplan and Baldauf (2003) suggested that, originally, LPP was an outgrowth of the positivist economic and social science paradigms dominant in the 1960s

and 1970s, arising as new nations emerged from disintegrated empires after the Second World War. For example, Fishman (1974), in his early work, viewed language planning and modernisation as the means for nation building in the postcolonial period of the 1950s and 1960s. Much of the focus during this early period of language planning was thus on the “rationalising” of languages to select a national language for the purposes of modernisation and related nation building (status planning), rather than just corpus planning per se—although the latter was seen as the means to do so (see Section 2.6 for further discussion). This model of LPP derived from the positivist orientation used in language planning at that time, emphasising a set of procedures that regulated and improved existing languages, or created new common and/or national languages in order to “solve” the social and political problems of newly emergent states (Ricento & Hornberger, 1996, p. 405).

In his synthesis of research during this early period, Ricento (2000) suggested that a widely held view among westernised sociolinguists at that time was that linguistic diversity—that is, multilingualism—presented obstacles for national development, while linguistic homogeneity was associated with modernisation and westernisation. While language planning was a new research discipline in the 1960s, as noted, this particular linguistic hegemony was not new to many contexts, including schooling. For example, one of the imperatives that underpinned the 1867 Native Schools Act in New Zealand, which decreed that English should be the only language used in the education of children, was based on similar linguistic hegemonies of “rationalising” languages so as to select a national language for the purposes of nation building (Simon, 1998).

Several summary accounts detail criticisms of early approaches to language planning, including those of Tollefson (2002), Ricento (2000) and May (2005). Criticisms include the argument that early language planning failed to analyse adequately the impact of national plans and policies on local contexts and the use of language planning by dominant groups to maintain their economic and political advantage. The latter went unseen because there was little reference to the role of ideology in language policy (Tollefson, 2002).

2.3.3 The second phase: Critical sociolinguistics and access (1970s–1980s)

By the 1970s, postmodern theories had emerged in reaction to the positivist outlook of early LPP work. Work in critical linguistics (Fowler, Hodge, Kress, & Trew, 1979; Halliday, 1978) and sociolinguistics (Hymes, 1972) was increasingly challenging positivist linguistic paradigms. These developments, referred to as “critical theory” approaches (Ricento & Hornberger, 1996, p. 406), sought to explain LPP in light of cultural, political, historical and economic influences, influencing the field of language planning. Ricento (2000) characterised the second phase of work in LPP as one in which:

There was a growing awareness of the negative effects—and inherent limitations—of language planning theory and models, and a realisation that sociolinguistic constructs such as diglossia, bilingualism, and multilingualism were conceptually complex and ideologically laden and could not be easily fit into existing descriptive taxonomies. (p. 14)

The role of ideology in LPP was also investigated more specifically by researchers influenced by key critical social theorists within sociolinguistics. Tollefson (1991, 2006) and Pennycook (1989, 2001) highlighted language inequalities that were apparent in both developed and developing countries, together with the idea that LPP represented only the ideologies of dominant powers. Tollefson (1991) added that language policy was one mechanism by which dominant groups established hegemony in language use.

Later writers in LPP such as Wright (2004) argued that LPP should be placed explicitly within broader social and political contexts. She suggested that “language planning plays a crucial role in the distribution of power and resources in all societies” and it is “integral to such activity and deserves to be studied explicitly from this political perspective” (Wright, 2004, p. 1). According to Blommaert (1996),

language planning carries implicit assumptions about what a “good” society is, about what is best for the people, about the way in which language and communication fit into that picture, and about how language planning can also contribute to social and political progress. (p. 215)

From this critical perspective then, language planning is viewed as an ideological discourse of government policy and, as such, should address larger social and political matters within which language change, use and development, and indeed language planning itself, are embedded. Collectively, this research (Pennycook, 1989; Tollefson, 1991, 1995; Wright, 2004) corresponded to what has been described as a “historical-structural approach” to LPP, which has remained a popular method of interpreting how language policy is implemented and how it operates within society (Ricento & Hornberger, 1996, p. 406). Tollefson (1991) suggested that the historical–structural approach looks at the social structures (class), which put constraints on the choices people make. He further added that historical and structural processes shape human behaviour and therefore issues of power, ideology, the state, hegemony, dominance and social structure (class) play a crucial role in the analysis of policies (Tollefson, 1991, p. 234). The utilisation of this methodology may aid in understanding *te reo Māori* history, in which national ideologies have affected how Māori individuals think about their language, and consequently language use at the *whānau* (family) level.

In contrast to previous LPP work, scholars such as Wolfsan and Manes (1985) eventually focused on the social, economic and political effects of language planning. Additionally, Spolsky (1995), whose work and views have significantly influenced Māori language revitalisation efforts, highlighted that language planning exists within a complex set of social, political, economic, religious, demographic, educational and cultural factors. Language needs to be looked at in its widest context and not treated as a closed universe. This view is markedly different to the views on LPP held by early writers, who regarded the process as more of a technical exercise carried out by linguists (Cobarrubias & Fishman, 1983).

The earlier attempts at language planning, which focused solely on a technocratic approach to solving language problems, were also criticised by Luke, McHoul and Mey (1990). They concluded that language planning needed to examine the discourse of language politics and the social aspects of language policy in order to understand it fully (Luke et al., 1990). These concerns are similar to those of researchers of critical

discourse analysis and poststructuralist and critical theory (Fishman, 1994). Ricento (2000) suggested it was also during this period that the key role of agents and agencies came to be considered in language planning. As language planning moved from being viewed as a set of scientific procedures to having a focus on context, the role and motivations of planners took on greater importance (Ager, 2001). Language policies were now seen as manifestations of ruling elites, motivated by the will to assert and protect their own socio-political and economic interests. Individuals at the bottom of the power structure are therefore constrained by such ideology, which governs all levels of institutions (Donakey, 2007).

Previously, language planning was also considered ideologically neutral and the languages were abstracted from their socio-historical contexts; the roles of individuals and collectives in the processes of language use, and their attitudes and beliefs, were frequently not discussed (Ricento, 2000). In human resource terms, these people are the language teachers, material developers, the curriculum specialists and so on who participate in both micro-level activities and macro-level language planning activities, although they may not be aware that this is what they are doing (Kaplan & Baldauf, 1997). In a much earlier work, Cooper (1989) considered other components of the language planners' work as the basis for developing a "process framework" for language planning. This included what actors attempt to influence what behaviours of which people for what ends under which conditions. Haarmann (1990) added that there are different levels of "agency" in language planning—for example, the government, various agencies, pressure groups and individuals. As Liddicoat and Baldauf (2008) have more recently pointed out, it is often these local contextual agents that have most affected macro-level language plans and the outcomes they have achieved. They also suggested that at the most micro-level of language planning, work is sometimes located with particular individuals who operate to revive or promote the use of the language. So, unlike the first stage of LPP, there was now a place in language planning research for addressing directly the broader historical, social and political issues underpinning each context.

2.3.4 The third stage: Postmodernism, linguistic human rights

The third stage in language planning research started about the mid-1980s and continues to the present day. At this stage, research turned to the topic of language ecology, with a focus on multilingualism and the state of endangered languages. Hornberger (2002) considered the language ecology metaphor “as a set of ideological underpinnings for a multilingual language policy” (p. 35). In particular, she pointed to how languages exist and evolve in an ecosystem along with other languages, and how their speakers “interact with their sociopolitical, economic and cultural environments” (p. 35). From the 1990s, academics such as Skutnabb-Kangas (2000), Phillipson (1992) and May (2001, 2005) have provided a language rights (LR) and/or human rights perspective on language ecology.

One of the principal concerns of LR is that establishment of minority/majority language hierarchies is neither a natural process nor primarily a linguistic one (May, 2012). Rather, “it is a historically, socially and politically construed process, and one that is deeply imbued in wider (unequal) power relationships” (May, 2012, p. 2). The LR paradigm argues that minority languages such as *te reo Māori*, and their speakers, should be accorded the same rights and protections that majority languages already enjoy (Skutnabb-Kangas, 2000).

Fishman (1991, 2001), Romaine (2006) and Nettle and Romaine (2000) published research on language *shift* and *loss* and the threat posed to thousands of the world’s languages from the dominance of other languages. Hinton and Hale (2001) focused on the rights of indigenous groups to maintain their identity and language. In discussions on language loss, Phillipson (1992) used the term “linguistic imperialism”, in which

language becomes a vector and means by which an unequal division of power and resources between groups is propagated, thwarting social and economic progress for those who do not learn the language of modernity and or the dominant group. (p. 47)

Phillipson’s (1992) theory provided a powerful critique of the historical spread of English as an international language, and how it continues to

maintain its current dominance, particularly in postcolonial contexts such as Aotearoa/NZ.

The critique of linguistic imperialism has sparked a heated controversy. In support of English, Crystal (1997) does not see English as an instrument of imperialism but as a tool that “presents us with unprecedented possibilities for mutual understanding” (p. viii). Also supporting the role of English is Davies (1996), who argued that two negative cultures inhabit linguistic imperialism: one is a culture of guilt (“colonies should never have happened”); the other is that of romantic despair (“we shouldn’t be doing what we are doing”; p. 485). The idea that the English language itself is imperialistic was dismissed by Widdowson (1998), who argued that “there is a fundamental contradiction in the idea that the language itself exerts hegemonic control: namely that if this were the case, you would never be able to challenge such control” (p. 398).

In response to these criticisms, Phillipson (1997) refuted the accusations of Davies (1996, 1997). Phillipson argued that from the perspective of minority speakers of dominated languages, the concept of language imperialism is important, since speakers who speak dominant languages, such as English, tend to see the expanded use of their languages as unproblematic. He further added that terminology such as “language spread” and “language death” contributes to a mythology of such social changes being attributable to agent-less natural forces. Phillipson (1997) also asserted, “linguicism (imperialism) may be overt or covert, conscious or unconscious, in that it reflects dominant attitudes, values and hegemonic beliefs about what purposes particular languages should serve” (p. 239). Skutnabb-Kangas and Phillipson (1996) highlighted that contemporary human rights law has decreed that discrimination on the basis of such features as race, gender and language is morally unjustifiable. Therefore, nation states have a duty to ensure the rights of speakers of “minority” languages such as indigenous languages (Skutnabb-Kangas & Phillipson, 1994).

A number of researchers have focused on linguistic discrimination in education—a practice that many would argue has been a characteristic of

the Aotearoa/NZ education system. Paulson and Heidemann (2006) cited several examples in the education of linguistic minorities to this end. The aim of their research was to “contextualise the relations of power and inequality that characterise the landscape of language planning within education, in order to (re) emphasise that language policy is never simply and only about language” (Paulson & Heidemann, 2006, p. 305). Mathematics educators have also taken up the issue of linguistic discrimination. For example, Barwell (2003, p. 37) suggested that the language used in schools, as in wider society, is closely bound up with issues of “access, power and dominance”. Consequently, minority languages may be devalued, and speakers of such languages potentially disadvantaged. Therefore, an education system that assumes students from minority groups should be taught subjects such as mathematics only through a majority or dominant language is an example of linguistic discrimination (Barwell, 2003).

It is in the second and third periods of language policy research—in effect, from about the 1980s to the present day—that most of the research into *te reo Māori* language shift in Aotearoa/NZ is situated.

2.4 Language Planning or Language Policy

Although the field of study is generally called language planning, the use of this term in its generic sense is somewhat confusing since it actually refers to several different aspects. For example, language planning is used to define both the *process* and the *study* of language activities. In sociolinguistics, the use and meaning of the terms “language planning” and “language policy” are also frequently contested. Since the emergence of the field of language planning in the early 1960s, the terms language policy and language planning have been interpreted and defined in a number of different ways, and used synonymously or in tandem in a range of literature, often referring to the same idea (Cooper, 1989; Haarmann, 1990; Haugen, 1968; Kaplan & Baldauf, 1997; Tollefson, 1991). Traditionally, language planning has been seen as the deliberate, future-oriented systematic change of language code, use and speaking, most visibly undertaken by government in some community of speakers—which leads to the promulgation of language policies (Fishman, Gupta, Jernudd,

& Rubin, 1971). This definition is consistent with other writers who have also defined language planning as a social construct that may involve the discursive production of a language policy (Alexander & Heugh, 1999; Blommaert, 1996; Jernudd & Neustupný, 1991; Kaplan & Baldauf, 1997). Fishman et al. (1971) contended that language policies are decisions taken by constituted organisations with respect to the functional allocation of codes within a given speech community. This view was supported by later researchers, including Kaplan and Baldauf (1997), who argued that language planning and language policy represent quite distinct aspects of the systemised language change process. Baldauf (1994), in an earlier work, suggested that language policy represents the *decision-making process*, formally stated or implicit, used to decide which language will be taught to whom and for what purpose. Thus, language policy is the body of laws, ideas, regulations, rules and practices intended to achieve language change in the society, group or system (Kaplan & Baldauf, 1997). What is of interest to this thesis is that in Haugen's (1983) and Kaplan and Baldauf's (2003) language planning models, policy planning can be narrowed down to the policy that affects the "selection" and "standardisation procedures" in corpus planning. Considering the range of definitions, language policy can be broadly considered the expression of particular ideological orientations and views on language(s) in particular contexts (Kaplan & Baldauf, 2003), and language planning the implementation of those beliefs, ideologies and views (Bakmand, 2000; Kaplan, 1994).

While current paradigms thus make a distinction between language policy and language planning, language policies are probably best considered a subset of language planning. For the purpose of this thesis, the important consideration is the issue of connectedness between the various LPP categories, as well as how useful theories and LPP frameworks are as pedagogical devices to investigate the issues associated with the development of a *reo Māori* mathematics (*pāngarau*) register.

2.5 Categorising Language Planning Processes and Activities

Language planning researchers have frequently used the term "typology" to describe language planning activities (see Hornberger, 1994; Stewart,

1968). However, rarely have they defined the term. In this study, the various typologies of language planning discussed further below refer to how the different processes, goals and practices are *categorised* or *classified* by researchers. Language planning researchers have traditionally drawn a significant distinction between language planning processes/steps, which involve a series of activities, and language planning goals/functions (see Hornberger, 1990; Nahir, 1984). Researchers of language planning have also suggested various typologies of language planning activities in order to carry out specific language functions. For example, Kloss's (1969) dichotomy contains status and corpus planning. Haugen's (1983) typology consists of selection, codification, implementation and elaboration. Neustupný's (1974) classification is composed of policy approach and cultivation approach. Hornberger (1994) considered policy (concerning matters of society and nation) and cultivation planning (relating to language and literacy at the micro-level). Hornberger (1994) also used Cooper's (1989) distinction of three types of planning, which Cooper had adapted from Kloss (1969): status planning (about uses of language), acquisition planning (about users of language) and corpus planning (about language).

Language planning has also been categorised according to its underlying aims and the ways in which it operates within particular societies. The diversity of political, ethnic and linguistic situations can greatly influence the goals and outcomes of language planning (Ricento, 2000). However, Kaplan and Baldauf (1997) noted that researchers in language planning have nonetheless attempted to differentiate two distinct kinds of language planning activities: those concerned with attempts to modernise the language (corpus planning), and those concerned with modifying the environment in which a language is used (status planning). Although status planning and corpus planning involve different activities, the relationship between these two types of planning processes can be considered complementary (Clyne, 1997). Cooper (1989) added a third focus: acquisition planning. Some researchers, for example, Kaplan and Baldauf (2003), have adopted this latter focus in models of language planning in the form of language in education.

2.6 Major Categories (Typologies) of Language Planning

The following section examines in depth the three major types or categories of language planning activities in LPP research, discussed previously, that are most relevant to this study: status planning, corpus planning and language-in-education planning. Status and corpus planning have been combined under one subheading since, as Fishman (2000) argued, “corpus planning, in itself, is an expression of a status planning agenda, albeit in more muted, disguised, or indirect terms than the overt governmental or other authoritative declarations” (p. 48). The subdomains of each major category will also be discussed.

2.6.1 Status and corpus planning

Although there is not complete agreement on the definition of this terminology, Ridge (1996) proposed that status planning involves decisions a society or group must make about language selection and implementation. Kaplan and Baldauf (1997) added that status planning also refers to deliberate efforts to allocate the functions of languages and literacies within a given speech community, particularly within the official domains of language use, such as those of the government and education. Such decisions involve status choices, for example, making a particular language or variety an official language or a national language. Often the decision involves elevating a language or dialect into a prestige variety, which may be at the expense of competing languages and or dialects. This may result in a language policy that is a “product of the powerful political and social aspects of language planning” (Kaplan & Baldauf, 1997, p. xiii). From such a perspective, it has been argued that language status planning issues are related to political issues; thus, the outputs of status planning are laws, clauses in constitutions and regulations prescribing the official standing of languages and their use in social domains of public administration (Cobarrubias & Fishman, 1983; Lo Bianco, 2004).

Corpus planning, on the other hand, focuses on changes by deliberate planning to the actual corpus or shape of a language itself (Ferguson, 2006). Corpus activities have usually been undertaken by language

experts, resulting in the production of grammars, dictionaries, literacy manuals and writing-style and pronunciation guides (Ferguson, 2006; Lo Bianco, 2004). According to Haugen's model, a norm is selected and then codified through orthography, grammar and lexicons (Anita, 2000). Corpus planning, therefore, refers to linguistic intervention in the form of a language. This may be achieved by creating new words or expressions, modifying old ones or selecting among alternative forms (Kaplan & Baldauf, 1997). Corpus planning aims to develop the resources of a language so it becomes an appropriate medium of communication for modern topics and forms of discourse, equipped with the terminology needed for use in administration, education and so on. Corpus planning is often related to the standardisation (codification) and elaboration of a language, involving the preparation of a normative orthography and grammar (Clyne, 1997). However, like status planning, corpus planning is driven by political considerations extending beyond the code itself (Ferguson, 2006).

2.6.2 Subcategories of corpus planning

Standardisation/codification

Standardisation is perceived as a corpus planning activity. A crucial part of the standardisation process is "codification". Based on Haugen's (1983) and Kaplan and Baldauf's (2003) models, codification of a language focuses on the standardisation procedures needed to formalise and develop a linguistic set of language norms. The goal of codification is to minimise variation in form and to maximise variation in function (Haugen, 1983). Accordingly, the theory is that language planners should work with the goal of minimising misunderstanding and maximising efficiency (Milroy & Milroy, 1985). Corpus planning can take place amid conflicting interests prevalent in the social context (Cooper, 1989; Jernudd & Neustupný, 1987). For example, Fishman (1988) pointed out that, unfortunately, the need to standardise a language for economic and political goals is sometimes used as an argument to eliminate the languages of linguistic minorities.

Haugen (1983) suggested that the codification of a language could be broken up into three areas: graphisation, grammatication and lexication. Graphising refers to the development of writing systems, that is, the transformation of an oral language to a written one, which has been considered the first step in the standardisation of a language (Kaplan & Baldauf, 1997). Graphising of an indigenous language is not without controversy, for example, the problems of graphisation in the Andean languages, in which dialect variation has been sacrificed in the interest of a normative writing system (Hornberger, 1994).

According to Kaplan and Baldauf (1997), grammatication involves the development of grammar rules that describe how a language is structured. Most of the grammars developed for various world languages have been prescriptive and based on the standardised variety of the language, especially languages used in schooling or for literacy development (Kaplan & Baldauf, 1997). (For comprehensive Māori language descriptors, see Bauer, 1997; Biggs, 1969; Harlow, 2001). Lexication refers to the selection and development of an appropriate lexicon (Kaplan & Baldauf, 1997). In the initial stages, lexication may involve the number of specific words used in particular domains. Kaplan and Baldauf (1997) suggested that the lexicon of a local vernacular will likely be rich in resources to deal with traditional areas of communication, but may not be sufficiently rich in technical terms necessary for modernisation. New lexicons may need to be devised using several different principles: foreign words may be borrowed directly from other languages and modified phonologically; words may be invented from borrowed roots; words no longer in use may be revived; and new combinations of existing words can be employed to reflect new concepts—for example, calquing approaches (Kaplan & Baldauf, 1997). In linguistics, to “calque” means to “borrow” the meaning or idiom word from another language, in contrast to “loanwords”, which are words that are borrowed and incorporated into the target language (Crystal, 2003a).

Kaplan and Baldauf (1997) argued that the processes of graphisation, grammatication and lexication, which make up corpus planning, are essentially linguistic issues. In contrast, they suggested that status

planning deals primarily with political matters. However, the reality for indigenous LPP, including languages such as *te reo Māori*, is that political tensions have simultaneously impacted on corpus planning. These tensions are discussed in detail in Chapters 9 and 10.

Language elaboration

Elaboration of a language focuses on the functional development of that language to enable it to operate in new domains (Kaplan & Baldauf, 1997). According to Haugen (1983), once a language has been codified, there is a need to continue “the implementation of the norm to meet the functions of a modern world” (p. 373). Additionally, Haugen suggested that a language in the process of being modernised must meet the wide range of cultural demands placed on it, in terms of both terminology and style. However, elaboration is not merely a matter of increasing the richness of the vocabulary—more is required (Kaplan & Baldauf, 1997). Kaplan and Baldauf (1997, 2003) maintained that the government and its agencies must encourage the use of the language in every possible sector, so that internalisation of the language occurs across the population at a rate much greater than that just through the education sector. The idea that state agencies must encourage usage of the elaborated language in a wide range of domains, including television, employment, printed material and so on, is promoted by recent reports into the state of *te reo Māori* (see Paepae Motuhake, 2011; Waitangi Tribunal, 1986, 2010). May (2005) makes a key distinction in his work between legitimisation (the formal recognition of a language, i.e., Māori Language Act) and institutionalisation (establishing normal use of languages in various language domains). He argued that the latter is the key indicator as to whether a minority language successfully re-enters the public domain, and questions remain as to whether this is in fact occurring with *te reo Māori* (May, 2005), at least beyond the realm/domain of education.

Kaplan and Baldauf (1997) contended that language elaboration is a complex and ongoing process and all languages have some mechanism for elaboration. Languages change as new technologies emerge or old technologies are abandoned; they develop contact with new groups of speakers of other languages or through expansion of commercial

activities. Kaplan and Baldauf (1997) advanced the idea that language communities need various mechanisms to modernise their language so that it continues to meet their needs. In the Aotearoa/NZ *te reo Māori* context, one of the mechanisms to modernise the language is the work of the Māori Language Commission (Te Taura Whiri i te Reo Māori) in standardising the language (see Harlow, 1993, for further discussion).

A component of language elaboration is terminology modernisation and, according to Kaplan and Baldauf (1997), it is the area that has generated the most discussion in corpus planning. In culturally, socially, technologically and economically changing conditions around the world, many new words are generated each year. Terminology development is a major preoccupation of language agencies and academics in countries that have language agencies such as Wales (Kaplan & Baldauf, 1997), as well as the work of specialist organisations, such as the Ministry of Education in Aotearoa/NZ (see Chapter 7). In many cases, new words either appear in inexplicable ways or can be attributable to a specific person, such as an inventor or marketer of the idea, or to a publication or event. For example, newly coined words from the world of marketing and electronic technology include *alcopop* (alcohol soft drink), *iBook/iPad/iPhone* and *tweet*. However, the strategies used to develop new terms, particularly for an indigenous language, can be contentious (see Chapter 9).

Related to language elaboration is the idea of language intellectualisation. The intellectualisation of a language involves the development of new linguistic resources for discussing and disseminating conceptual material at high levels of abstraction (Liddicoat & Bryant, 2002). In regard to teacher education, Meaney et al. (2012) referred to this as the mathematics education register. Finlayson and Madiba (2002) suggested that the development of academic discourse is a characteristic of most languages that are developing an expanded range of functions in their societies. However, Schiffman (1996) expressed scepticism about the intellectualisation process by citing examples of the lack of progress in the languages of India, where the indigenous languages were expected to replace English as a means of modern communication. Schiffman (1996)

argued strongly that it is not possible to develop registers in a language through a conscious effort. He believed that registers should develop naturally in the language through use and over time, as was the case in English (Schiffman, 1996). Despite Schiffman's scepticism, Finlayson and Madiba (2002) highlighted research conducted in a number of countries in which it is argued that good progress has been made in planned intellectualisation.

Although language intellectualisation may occur naturally, there is a growing consensus among language planning scholars that, in developing languages, there is a need for conscious and deliberate efforts to accelerate the process and to make it more effective (Finlayson & Madiba, 2002). In many countries, the role of intellectualising a language is frequently the responsibility of initial teacher education institutions, education faculties or departments, the media and literature (Gonzalez, 2002). It is questionable whether this is yet occurring for *te reo Māori* (Murphy, McKinley, & Bright, 2008), and this is discussed in depth in Chapter 8. The intellectualisation of languages has not been a priority area of LPP research nationally or internationally. Moreover, there appears to be minimal international and national literature on indigenous language initial teacher education in terms of its role in revitalising endangered languages.

2.6.3 Language-in-education (acquisition) planning

According to Kaplan and Baldauf (1997), language-in-education planning (equivalent to Cooper's 1989 notion of acquisition planning) substantially involves the state educational sector. According to Cooper (1989), acquisition planning is "directed toward increasing the number of users, speakers, writers, listeners, or readers of a language" (p. 33). Acquisition planning concerns the teaching and learning of languages, whether national languages or minority indigenous languages, and is often situated in schooling (Bakmand, 2000). The educational domain is usually chosen as an implementation site for language policies. Since educational institutions deal with the standard versions of language, and standard languages are considered a symbol of cultural unity, it follows that the role

of education is to induct individuals into the dominant culture of the society (Kaplan & Baldauf, 1997, p. 122).

O Laoire and Harris (2006) contended that the school has become one of the most critical sites for reversing language shift and for language revitalisation in endangered language contexts (cf. Chapter 1). Ferguson (2006) also argued that the school is perhaps the most crucial language domain, adding that the school often bears the entire burden of language planning implementation. One of the reasons for this is that education is most often controlled by the state, and thus can be readily used as an agency of state language planning. Second, education is also the site where the socio-political and ideological values of the language community are transmitted and reflected—the very values that may support language revival. Schools can, therefore, become agents of positive language change, raising language loss or language use issues with students and the language community, thereby influencing the linguistic beliefs and practices of the language community (Skutnabb-Kangas, 2000).

However, Kaplan and Baldauf (2005, p. 1013) highlighted a range of issues associated with the discontinuities that result from stand-alone language-in-education planning, including slow dissemination, lack of resources and limited audience. This relates to earlier work by Rubagumya (1990), who was of the opinion that in order for a language to function as the medium of instruction in schooling, it should also be used in some domains outside the schooling system. Examples include serving the needs of the community and the nation in local and international trade and commerce, as well as access to higher educational opportunities (Cook, 1991).

2.7 Levels of Language Planning: Defining Macro, Meso and Micro

It is appropriate now to consider whether the activities mentioned above belong to the category of macro-, meso- or micro-language planning. As noted, the considerable body of sociolinguistic literature examining LPP has traditionally focused on the actions of governments and similar macro-

level organisations. This is because the primary concern was creating national unity and developing and maintaining communication within emerging nations (Ricento, 2000). Local issues of language planning were seen as secondary to the overall process of planning (Liddicoat & Baldauf, 2008). Until recently, there has been some discussion of (but little scholarly work on) the idea that language planning can occur simultaneously at the macro, meso and micro-levels within a society (Baldauf, 2006).

Fishman (2006) and Spolsky (2004) pointed out that although language planning may involve government action, in practice, a great deal of language planning occurs in micro-structural environments, such as particular sectors of economic or social activity (Baldauf, 2006; Kaplan & Baldauf, 1997). More specifically, Baldauf (2006) defined micro planning as referring “to cases where businesses, institutions, groups or individuals create what can be recognised as a language policy and plan to utilise and develop their language resources” (p. 229). Accordingly, such planning occurs as a response to “their own needs, their own ‘language problems’, and their own requirement for language management” (Baldauf, 2006, p. 29). Micro-level language planning examples in Aotearoa/NZ include a school developing a *te reo Māori* policy and plan, or a *whānau* (family) developing their own personalised *te reo Māori* development plan.

Liddicoat and Baldauf (2008) suggested that one of the reasons for the marginalisation of micro-level language planning within the context of language planning research is definitional. Most definitions of language planning “presuppose deliberate planning by a national organised body such as a government agency, commission etc.” (Liddicoat & Baldauf, 2008, p. 3). However, Baldauf (2006) maintained that in order for language planning (and policy) to be successful, it needs to extend down through the system. It is a question of trying to manage the whole language ecology of a particular language—to support it within the vast cultural, educational, historical, demographic, political and social policies that occur every day (Kaplan & Baldauf, 1997). These aspects were also highlighted by Schiffman (1992), who contended that indigenous language planning often fails because these various aspects are not considered, and the

basic structural work is not done. This provides a cautionary message for the revitalisation of *te reo Māori*, particularly in the school domain.

Kaplan and Baldauf (1997, p. 5) identified four main areas at different levels concerned with language planning: (a) governmental bodies, (b) the educational sector, (c) quasi-governmental or non-governmental bodies and (d) individuals and organisations. Macro-level planning generally involves “top-down” national government policies. Meso-level planning may also involve government policy but has a much narrower focus, for example, language requirements for schooling. The micro, “bottom-up” level of planning includes school plans, community or *whānau* (family) groups, individual households and the language use of individual people. The issue of where the development of the Māori-medium mathematics terminology and register fits in the hierarchy of language planning is discussed in Chapter 9.

2.8 Language Planning Framework—in This Thesis

Academic research has outlined many differing frameworks of language planning over the past 40 years, and there have been several attempts to define the activities that make a language planning process, and to provide a description. The model that seems to have been adopted by a significant number of writers is the “two-by-two” conceptual model first proposed by Haugen (1983) and expanded on by Kaplan and Baldauf (1997, 2003). Haugen’s (1983) model (see Table 1) can be viewed from either a societal (status planning) or a language (corpus planning) focus, and by form (policy planning) or function (language cultivation; Haugen, 1983).

Table 1. Haugen's (1983) "revised language planning model with additions"

	<i>Form (policy planning)</i>	<i>Function (language cultivation)</i>
Society (status planning)	1. Selection (decision procedures) a. problem identification b. allocation of norms	3. Implementation (educational spread) a. correction procedures b. evaluation
Language (corpus planning)	2. Codification (standardisation procedures) a. graphisation b. grammatication c. lexication	4. Elaboration (functional development) a. terminological modernisation b. stylistic development c. internationalisation

Note from Kaplan, R., & Baldauf, R. (1997). *Language planning from practice to theory*. (p. 29). Clevedon, England: Multilingual Matters.

While Haugen's (1983) two-by-two model is conceptually useful when considering some of the language planning situations in Aotearoa/NZ, it has limitations. In reality, all stages may occur simultaneously and the issue of context must be considered. Planning involves both the language itself and the situations in which the language is being used. Spolsky (2004) suggested it is inevitable that changes in the language affect the registers in which the language is being used, and these changes in turn define, in a new way, the language situation. This view was supported by Kaplan and Baldauf (1997), who argued that, in practice, it is virtually impossible to separate the two activities. Any change in the character of language is likely to result in a change in the environment of use and vice versa.

To provide a theoretical grounding to investigate the development of Māori-medium mathematics and the various factors that have impacted on the process, the following section focuses on Kaplan and Baldauf's (2003) more recent integrative framework of language planning. The selection of this model was guided by a number of factors: first, as a consequence of the evolution of language planning, Kaplan and Baldauf (2003) maintained that language planning needs to be framed within its broad ecological context. Thus, they developed a revised and expanded version of the models presented by Fishman (1974), Haugen (1983), Hornberger (1994), Nahir (1984), Neustupný (1974) and a number of other researchers (see Table 2). Therefore, Kaplan and Baldauf's (2003) model is a reasonably up-to-date contribution which incorporates most of the above-mentioned

categories and frameworks, allowing an easy reference to and interaction with other frameworks, including Haugen (1983). Second, in addition to the goals of language planning, Kaplan and Baldauf's (2003) and Kaplan's (2006) models include interpretive explanations and considerations of language planning at different levels –macro, meso and micro (see Table 2). This is of interest to this thesis in which *te reo Māori* planning is investigated at these different levels. Third, Kaplan and Baldauf (2003) agreed that both policy (form) and planning (i.e., function), as presented by Haugen (1983), need to be considered, but added that policy and planning should be viewed from an overt (explicit) and/or covert (implicit) perspective as well. In addition, when LPP is undertaken, there is a significant underlying historical and social component that helps to frame the work (Kaplan & Baldauf, 2003). Finally, Kaplan and Baldauf's (2003) integrative model of language planning includes language-in-education planning. A significant component of this thesis is a critical examination of the development of Māori-medium schooling in response to *te reo Māori* revitalisation efforts.

A framework reflecting these additions and elaborations in greater detail is set out in Table 2. A number of these activities are considered in this study in relation to *te reo Māori* planning generally, and the evolution of Māori-medium schooling and the related development of the specialised Māori-medium mathematics terminology and register in particular.

Table 2. Model of language planning

	Levels of language planning		
Approaches to goals	Policy planning	Cultivation planning	Macro-, meso-, micro-levels
Productive goals Status planning (about society)	Goals Status standardisation <ul style="list-style-type: none"> • Officialisation • Nationalisation • Proscription 	Goals Status planning revival <ul style="list-style-type: none"> • Restoration • Revival • etc. 	Awareness of goals Overt covert planning
Corpus planning (about language)	Standardisation <ul style="list-style-type: none"> • Graphisation • Grammatication • Lexication 	Corpus elaboration Lexical modernisation Stylistic modernisation Renovation <ul style="list-style-type: none"> • Purification • Reform • Terminology unification • Internationalisation 	
Language-in-education planning (about education)	Policy development <ul style="list-style-type: none"> • Access policy • Personnel policy • Curriculum policy • Resources policy • Community policy • Evaluation policy 	Acquisition planning	
Receptive goal Prestige planning (about image)	Language promotion <ul style="list-style-type: none"> • Official/government • Institutional • Pressure group individual 	<ul style="list-style-type: none"> • Intellectualisation • Language of science • Language of professions • Language of high culture 	

Note from Kaplan, R., & Baldauf, R. (2003). *Language and language-in-education planning in the Pacific Basin*. (p. 202) Dordrecht, The Netherlands: Kluwer Academic.

This framework is useful as a pedagogical device for examining the scope of language planning in a particular context, for example, the development of the *pāngarau* register. However, Baldauf (2006), one of the authors of the (2003) framework, suggested it should not be seen literally as a map of either how to do language planning or what happens in real-life situations.

2.9 Approaches to *te Reo Māori* Planning and Policy—in This Thesis

This thesis utilises a number of complementary analytic approaches, variously discussed in previous sections, to critique *te reo Māori* macro, meso and micro planning and policy discussed in Chapters 4 and 5 and

the data Chapters 7 and 8. These perspectives best reflect my own personal orientation to language planning developed here. These approaches or perspectives are all located in Ricento's (2000) third stage of language planning evolution; that is, they are based on critical theory and linguistic human rights frameworks that are also linked to *kaupapa Māori* theory. According to Smith (1997), the advancing of *te reo Māori* rights are central to *kaupapa Māori* theory, which is predicated on, among other things, the principle of self-determination and alleviating the negative pressures on Māori communities and families (*kaupapa Māori* theory is discussed in more detail in Chapter 6).

Another approach drawn on in this study to examine *te reo Māori* historical and political context are the theories of *linguistic imperialism* and *assimilation*, as highlighted, for example, by Phillipson (1992). In the Aotearoa/NZ context, linguistic imperialism has often been manifest in the practice of linguistic assimilation. These issues are considered in more depth in Chapter 4.

2.10 Language Development Terms

The use of terms such as 'modernisation' to categorise the language development of minority indigenous such as *te reo Māori* can be contentious, because if a language is being 'modernised' it therefore must be 'outdated' or 'antiquated'. This may imply a hierarchy of languages from modern to primitive. Like many linguistic terms, the definition of a 'modern language' is rather ambiguous. This thesis takes the view that because languages such as *te reo Māori* are used for day-to-day communication, as opposed to classical languages, such as Latin, it can be considered a modern language. Therefore, the principle terms used in this thesis to denote the development of *te reo Māori* to teach subjects such as mathematics are 'adaption' and 'elaboration' rather than modernisation. As noted, the elaboration of a language focuses on the functional development of that language to enable it to operate in new domains, i.e., new registers (Kaplan & Baldauf, 1997). However, in order to elaborate a language, sometimes it is necessary to 'modernise' the lexicon and register—particularly so in culturally, socially, technologically and economically changing conditions (Kaplan & Baldauf, 1997).

2.11 Summary

In summary, the major themes identified in the literature on language planning and policy show that the definition and theories of LPP have evolved over time as research disciplines have evolved. The field of LPP, significantly influenced by other research disciplines such as critical theory, has transitioned over the years, from viewing language planning as a purely technical process to solve a language problem (e.g., standardising an orthography), to one in which the focus is on the linguistic rights of minority and/or indigenous groups. As approaches and theories of LPP have evolved, so too have the key concepts and terminology. The key domains and categories involved in the process of language planning have been identified in this chapter, as have the key theoretical and analytical approaches.

The language planning framework presented by Kaplan and Baldauf (2003), as examined in this chapter, is used in subsequent chapters to provide a theoretical basis to investigate *te reo Māori* planning issues at different levels—the macro, meso and micro. Language planning in this thesis refers to any practice that causes change in the language and/or its use, irrespective of the scale. Much of LPP research has focused to date on macro-level government actions. However, a great deal of language planning occurs at different levels, including the meso and the micro. Schools often represent an interface between macro-level and meso- and micro-level language planning. The educational domain is often chosen as an implementation site for national language policies, either overt or covert, because education is most often controlled by the state and thus can be readily used as an agency of state language planning.

The next chapter examines the development of SFL, as presented by Halliday (1978) and others, to examine the mathematics register for schooling. Chapter 3 also examines the development of the English-medium mathematics register and literature concerned with developing mathematics registers for indigenous languages.

Chapter 3. Register Theory and Mathematics

3.1 Introduction

This chapter is concerned with the investigation of two major themes to do with register: the first is the evolution of SFL and theories of “register” promulgated primarily by Halliday (1978). The second theme is the development of the mathematics register in English, multilingual and indigenous language contexts. This provides a theoretical basis, along with the more general LPP theories described in the previous chapter, to consider the development of the Māori-medium mathematics register in later chapters.

This chapter also examines issues to do with the mathematics register from two different but interrelated perspectives. The first is the notion that mathematics, or arithmetic, as it was known earlier, is a central component of the school curriculum around the world. Moreover, it was and still is a high-status subject (Harris, 1997), and success or otherwise in the subject may have implications for further study and career options for students. As a consequence, there has been considerable interest in the linguistic and sociolinguistic aspects of teaching and learning mathematics, from both mathematics educators and applied linguists, dating back to at least the 1950s (Bishop, 1996). The second area of research interest is pedagogical, and is based on issues to do with the learning of the register (Pimm, 1987).

3.2 The Development of Register Theory

A significant body of research examining language issues in the learning and teaching of mathematics has recognised that language use in school differs in some important ways from language use outside of school. Moreover, subjects such as mathematics are characterised by specific registers (see Halliday, 1978; Halliday & Hasan, 1985). However, the term “register” as it is used in linguistics is contested, and commentators use it in various ways, including those who have focused on indigenous languages (Barton et al., 1998). A number of terms have been used to refer to the construct that characterises the specialised language of mathematics, including “register”, “style” and “discourse”. These terms are

often used interchangeably but can represent quite different concepts in the literature. Therefore, it is important to identify which definition is being used in this thesis, particularly in regard to the idea of the register in applied and sociolinguistic research. The following sections examine the origins and definitions of the term “register” and its use in mathematics education.

Discussion on the features and definitions of the mathematics register can be traced back to studies using register theory and the much broader field of SFL, sometimes known as Hallidayan linguistics after Halliday, the major proponent of the theory (Schleppegrell, 2004). While categorising the newly created *pāngarau* register is not a major component of this thesis, it is through the work in SFL that definitions of the mathematics register were initially formulated, and issues to do with learning the register have subsequently been discussed (for example, see Dale & Cuevas, 1992).

The foundations of the sociolinguistic work of both SFL and Halliday (1978) have proceeded from a functionalist perspective of language, in contrast to formalist views such as Chomsky’s (1957) development of transformational-generative grammar. The classical linguistic “formalists”, exemplified by Chomsky, asserted that language is an innate universal feature of human beings, and that the different languages are mere manifestations of this feature (Crystal, 1995). Chomsky was concerned only with the formal properties of languages such as English, which he believed was indicative of the nature of what he called universal grammar (Chomsky, 1966). Chomsky’s theory of universal grammar suggested that, although groups of people speak different languages, all human languages are essentially governed by common rules or principles that are universal, and linguistic form can be characterised independently of meaning and function (Chomsky, 1966).

Under Halliday’s (1978) view of language, even if it were a universal feature, language cannot be separated from context (and thus culture). Hence, the universal grammar as promulgated by Chomsky would not have relevance without real-life contexts and experiences. Unlike Halliday,

Hymes (1972), one of the most influential writers in sociolinguistics, publicly took issue with Chomsky for the failure of his transformational-generative grammar to account for linguistic variation. Chomskyan linguistics focused on the aspects of language that are uniform across speakers, ignoring language variation by stipulating idealised speakers/hearers in completely homogeneous communities as its research object (e.g., Chomsky, 1957). In contrast, Hymes (1972) was concerned with actual linguistic diversity as found in speech, and suggested that studies of language should be grounded in ethnographic study rather than introspective theorising. The work of Halliday (1978) also inspired work in critical linguistics (Fowler et al., 1979) that questioned traditional linguistic theory that ignored the sociocultural contexts. This critical work in turn influenced LPP.

The focus of SFL is thus on how people use language and how language is structured for use. Because language situations differ, the primary construct in SFL theory for explaining linguistic variation is the register. According to de Beaugrande (1993), the forerunner of the concept of register was the term “restricted language” discussed in foundational linguistic works (p. 7). Firth (as cited in Leon, 2007, p. 1) also talked of “restricted language”, which “can be said to have its own grammar and dictionary. Firth (as cited in Leon, 2007, p. 9) considered science, technology, politics and sports as domains of restricted language. The early work of Bernstein (1971), where he discussed the concepts of restricted and elaborated codes, also subsequently influenced Halliday’s work (Lowe, 2008). Halliday (1964) suggested that the term register was first used in a linguistic context by Thomas Bertram Reid in 1956 and was brought into currency in the 1960s by a group of linguists who wanted to distinguish between variations in language according to the user, and variations according to use. However, Halliday, a disciple of Firth, is perhaps too modest here because many researchers have subsequently suggested that it was the seminal work of Halliday (1975a, 1978) himself, albeit clearly influenced by the work of Firth, Bernstein and Whorf, that eventually gave currency to the term register in academic research (Lewandowski, 2010).

The central premise of SFL is that language is functional and varies according to the situation in which it is used, and these varieties of language can be referred to as registers (Halliday, 1978; Halliday & Hasan, 1985, 1989). A central notion is ‘stratification’, such that language is analysed in terms of four strata: Context, Semantics, Lexico-Grammar and Phonology-Graphology (Halliday, 1978). Context was interpreted by Halliday (1978) as the linguistic features typically associated with a configuration of situational features: the “field”, the “mode” and the “tenor” (see Appendix A). These three values—field (the context), mode (the social roles and relationships) and tenor (how it is communicated)—are thus the determining factors for the linguistic features of the register as proposed by Halliday (1978) and expanded on by Halliday and Hasan (1989).

Meaning (semantics) in SFL is analysed in terms of three metafunctions. The metafunctions of language are to: understand the environment (ideational meaning); how people act in the situation (social meaning); and how the text is structured as a message (textual meaning) (Mathiessen & Bateman, 1991). These three metafunctions relate to the field, the mode and tenor described above. The lexico-grammar concerns the syntactic organisation of words based on the function of the language and the word options the speaker (or writer) chooses (Halliday, 1996). For example, a speaker could choose to express a mathematical instruction in either active or passive form.

Halliday’s later definitions tend to place a primary emphasis on semantic patterns and context. According to Halliday (1996), the term register refers to specific lexical and grammatical choices made by speakers depending on the situational context, the informants in the conversation, and the function of the language in the discourse. The common feature in these definitions of register is the view that both “situational and linguistic variables need to be part of register characterisation” (Leckie-Tarry, 1995, p. 7).

Halliday (1985) also saw the context of situation embedded specifically within the wider context of culture, both of which are incorporated in the

text by the users. This idea also supports the notion that mathematics is a social and cultural construct, an idea underpinning much of the recently established research domain of ethnomathematics (Barton, 2008), and related discussion on the role of culture in mathematics education (Bishop, 1991).

3.3 Descriptions of the Register in Linguistics

Many theorists have acknowledged the influence of Halliday in the development of their perceptions of register. For example, Gregory and Carrol (1978) viewed a register as an example of “language in action” (p. 4). Assuming a textual perspective, they argued that registers should be discussed in terms of text-specific phonology, lexical and grammatical markers and common core features that are typical of a particular type of text (Gregory & Carrol, 1978). Like Halliday (1985), they also stressed the importance of cultural factors in the creation of registers, since it is the culture of the society that determines the environment and/or situations in which language interaction occurs (Gregory & Carrol, 1978). Other sociolinguistic researchers have viewed register as a continuum. For example, Zwicky and Zwicky (1982) suggested that at one end are classical examples of the register characterised by strong links between linguistic and situational factors (e.g., recipes). At the other end of the spectrum lie varieties exhibiting a small number of register features, such as the language of advertising, which the authors regarded as a collection of various styles and registers (Zwicky & Zwicky, 1982).

Wardhaugh (1986) restricted the domain of the term register to a specific vocabulary, as used by various occupational groups or in specific situations (this could include academic jargon). However, this narrower definition of the concept seems unacceptable because, as suggested by Halliday and others, register analyses should not be restricted solely to vocabulary but should include other aspects of language (see Halliday, 1975a, 1978). Wardhaugh (1986) also emphasised a different set of registers, referring to them as “sets of language items associated with discrete occupational or social groups” (p. 22). This definition would include the registers employed by specific groups, for example, the register employed by traditional Māori carvers or weavers. However, the

concept of register advocated by Halliday (1978) and others is strongly associated with situations of use rather than with specific groups or individuals.

The use of the term register in linguistics was criticised by Crystal (1976), who believed the term was being indiscriminately applied to every possible variety of language. Moreover, Crystal (1976, p. 61) asserted that different “situational contexts have not been sufficiently studied to establish a finite set of register labels” (p. 61). As with other types of language variation, Crystal (1976) postulated that rather than a discrete set of obviously distinct varieties, there was a spectrum of registers with no clear boundaries.

3.3.1 Contested definitions: Register, genre, style and discourse

The vagueness of the term register, coupled with allied definitional confusion, has led to some researchers arguing against the use of the term altogether, and as a consequence, they have presented alternative concepts. For some functional theorists, the concept of register is not sufficient to capture the relationship between situational and linguistic variables (Leckie-Tarry, 1995). According to Leckie-Tarry (1995), these theorists found the category of “genre” more effective in representing the theoretical construct between language function and language form. The terms “genre” and “register” are often used interchangeably, primarily because they overlap to some degree. As a consequence, there is considerable variation in the definitions and conceptualisations of register and genre (Leckie-Tarry, 1995). For example, in Crystal and Davy (1996), the word “style” is used in the way most other researchers use register, to refer to particular ways of using language in particular contexts. The authors felt that the term “register” had become too loosely applied to almost any situational variety of language of any level of generality or abstraction, and distinguished by too many different situational parameters of variation (Crystal & Davy, 1996). On the other hand, Lee (2001) pointed out that the Crystal and Davy (1996) definition went against the usage of “style” by most people in relation to individual texts or individual authors/speakers. One difference presented in the literature between the two is that “genre” tends to be associated more with the organisation of

culture and social purposes around language (Bhatia, 1993; Swales, 1990), and is tied more closely to considerations of ideology and power, whereas register is associated with the organisation of situation or immediate context.

Similar issues arise with the use of the term “discourse”, which is sometimes used interchangeably with register in linguistic and sociolinguistic research. There is no clear agreement among linguists as to the use of the term discourse, in that some use it in reference to texts while others claim it denotes speech, such as in the following definition: “Discourse: a continuous stretch of (especially spoken) language larger than a sentence, often constituting a coherent unit such as a sermon, argument, joke, or narrative” (Crystal, 1992, p. 25). From a wider perspective, discourse is a social practice that takes form through language use (Crystal, 1992).

Linguistic categorisation is a complex problem. Even in the general definition of register given by Halliday above (language variation defined by use not user), it has been suggested that there are cases where other kinds of language variation, such as regional or age dialect, overlap with the notion of register and are used interchangeably. For example, Sanders (1993) and Solano-Flores (2006) included regional background as a defining feature of register, even though this characteristic is essential to the notion of dialect. It is no surprise then that Hudson (1993) remarked, “one man’s dialect is another man’s register!” (p. 51).⁴

3.4 Framework for Analysing Linguistic Features of a Language

Research shows then that there is little consensus about the meanings of terms such as “register”, “field” or “tenor”, and more elaborate frameworks have subsequently replaced the triadic construct of register as advocated by Halliday and Hasan (1989). However, many frameworks delineated in the literature still roughly correspond to and build on the earlier frameworks presented by Halliday (1978) and Halliday and Hasan (1989), for example, the framework (see Appendix C) compiled by Biber and

⁴ See Appendix B for the differences between dialect and register according to Halliday (1978, p. 35).

Conrad (2009, p. 40) derived from a survey of previous theoretical frameworks (e.g., Biber, 1988, 1994; Crystal & Davy, 1996; Halliday, 1978; Hymes, 1974) that were developed for the study of register.

While there are some obvious differences between the Halliday and Hasan (1989) and Biber and Conrad (2009) frameworks (i.e., number of categories), both are concerned with identifying lexico-grammatical features that occur in specific social situations. This too is the perspective of this thesis on language register.

3.5 Definition of the Mathematics Register

Although researchers have long recognised the vital role that language plays in learning and teaching (Aikin, 1972), it was not until at least the 1970s that researchers highlighted its importance in the process of acquiring mathematical knowledge and skills (e.g., Cocking & Mestre, 1988; Mousley & Marks, 1991). Similarly, interest in the problems of mathematics learners whose L1 differs from the language of instruction was also brought to the fore in the early 1970s. Again, Halliday (1975b, 1978) was influential here. Halliday (1978), for example, addressed language difference (or “distance”) as an instructional obstacle and described a “register of mathematics”, which to this day is considered definitive in discussions about language and mathematics (Schleppegrell, 2007). The term “register” as it is used in linguistics, is thus both widely contested and used multifariously. However, the definition of “register” employed in this thesis is the one promoted by Halliday (1978), who defined the mathematics register in the following way:

A register is a set of meanings that is appropriate to a particular function of language, together with the words and structures that express these meanings. We can refer to “mathematics register”, in the sense of the meanings that belong to the language of mathematics (the mathematical use of natural language, that is, not mathematics itself), and that a language must express if it is being used for mathematical purposes. (p. 195)

Halliday (1978) highlighted that the kind of mathematics students need to develop through schooling uses language in new ways compared with the everyday language to serve new functions. This is not just a question of learning new words, but also new “styles of meaning and modes of

argument . . . and of combining existing elements into new combinations” (Halliday, 1978, p. 196).

3.6 Descriptions of the Mathematics Register

The primary motivation for considering the specific features of the mathematical register has its roots in research considering issues to do with the relationship between thought and language, the language of the learner and aspects of the register that are challenging for learners. Interest in and the study of relationships between language and the development of thinking are not new (see Bruner, 1966; Vygotsky, 1978, 1986). Theorists, for example, Whorf (1956), who suggested that language determines and defines thought, influenced Halliday and his theories on the register (Cuevas, 1984). In turn, the sociolinguistic work of Halliday (1978) subsequently influenced researchers examining mathematics learning in multilingual situations or in an L2 (Cuevas, 1984; Mestre, 1988; Pimm, 1987). Concerned with the considerable underachievement of Hispanic L2 learners in the United States, a group of language educators, including Spanos, Rhodes, Dale and Crandall (1988), categorised the linguistic features of mathematical problem solving. To support the development of a framework to examine the language of mathematical problems, they resurrected and mathematised a model first proposed by Morris (1955) in his seminal work on semiotics and subsequently adopted by Carnap (1955) to categorise the linguistic features of particular scientific domains (Spanos et al., 1988). The Morris (1955) model distinguished between the following three linguistic categories:

1. Syntactics—the study of how linguistic signs, or symbols, behave in relation to each other;
2. Semantics—the study of how linguistic signs behave in relation to the objects or concepts they refer to, or their senses, or how “meaning” is conveyed through signs and language (Halliday, 1978);
3. Pragmatics—the study of how linguistic signs are used and interpreted by speakers (Spanos et al., 1988, p. 224) and the study of how context affects meaning (Leech, 1983).

It is important to note that terms such as semantics and pragmatics also have contested definitions and are a study in their own right (Levinson, 1983). In their research into the linguistic challenges facing Hispanic L2 learners of English, Spanos et al. (1988) highlighted that the source of many of the difficulties faced by L2 learners of mathematics can be traced back to the complex interplay between these syntactic, semantic and pragmatic features that occur when students attempt to verbalise or interpret mathematical concepts in English (see Appendix D for features). This is supported by the earlier work of science and mathematics educators such as Cuevas (1984) and Mestre (1981), who suggested that the nature of mathematics and science language imposes a heavy burden on all students regardless of the language of instruction.

Researchers have since expanded on the notion that the mathematics register has specific vocabulary (Halliday & Martin, 1993; Otterburn & Nicholson, 1976; Shuard & Rothery, 1984). Collectively, these researchers have shown that the mathematics register word usage can be categorised in a number of ways, including:

1. Words that have the same meaning in mathematics as they do in everyday language (e.g., add);
2. Words that have a meaning only in mathematical language (e.g., hypotenuse);
3. Words that have different meanings in mathematics language and natural language (e.g., volume);
4. The same word in mathematics that may be used for a *process* and for a *thing* or *result* (e.g., reflection: it can refer to the process of reflecting or to the result of reflecting).

More recently, researchers have defined the mathematics register according to categories other than strictly linguistic ones. Davidenko (2006), expanding on a framework originally developed by Skemp (1992) and Hiebert and Carpenter (1992), constructed a framework based on mathematical *understanding* to analyse the mathematics register used to

communicate algebraic ideas. This framework (Davidenko, 2006, p. 165). attempted to differentiate between, among others, the:

1. Instrumental register: the verbs register—mostly formed by verbs to denote actions and sequences, e.g., add, divide;
2. Procedural register: the verbs and logical connectors register, e.g., if/then, and this/because;
3. Conceptual register: the nouns and adjectives register, e.g., a quadrilateral (noun) is a four-sided (adjective) polygon (noun);
4. Formal and symbolic register, e.g., symbols such as $<$, $>$, $+$, $-$, $(,)$.

Bagchi and Wells (1998) focused on types of mathematical discourse in the mathematical register and developed a taxonomy of mathematical prose, for example, definitions, specifications, theorems and proofs. Meaney (2005), in her discussion of a comparison between the language of mathematicians and the language of mathematics students, argued that while both sets of language use could be described as the mathematics register, the functions of the mathematics language is different in the two cases—one is to create new mathematics and the other is to learn mathematics.

3.7 Evolution of the English-medium Mathematics Register

The language of modern mathematics is part of the continuum of technical language development that began in Europe in the 17th century. While not always transparent in the English language, Closs (1977) and a number of other researchers have argued that modern mathematics has also drawn heavily on ancient language stocks from Europe, Asia Minor and North Africa, and may be said to represent the cumulative technical language development of diverse peoples over thousands of years. The evolution of mathematics also involves the evolution of the grammatical resources of the natural languages by which Western mathematics came to be constructed (Halliday, 1993). Inevitably, this involved the introduction of ways of referring to new objects or new properties or processes, functions and relations. Consequently, English-medium mathematical notation and terminology has also assimilated symbols and terms from many different

languages, alphabets and fonts. There are various ways in which this has been done. Halliday (1978) suggested that the most typical procedure in contemporary European languages for the creation of new technical terms was to create new words out of “non-native stock”, and that these terms were not normally used in everyday situations. For example, some mathematical terms such as “quadrilateral” and “parallelogram” are made up of Latin and Greek elements, even if the actual words did not exist in their original language. Pimm (1987) provided the example of reinterpreting existing words by changing their grammatical category and function, such as numbers in ordinary English that function usually as adjectives, but in mathematics discourse can also serve as nouns. Inventing totally new words was rare in English technical language for some time (Pimm, 1991). However, this is changing—there are now words evolving in contemporary English. An example is nanosecond. ‘Nano’ is a prefix meaning extremely small. When quantifiable, it translates to one-billionth. However, it comes from the Greek word nanos (νάνος), which means dwarf.

Halliday (1978) suggested that, for the most part, the development in English-medium mathematics was not through the creation of entirely new linguistic structures but via adapting and elaborating existing structures. This development has taken place slowly, by more or less natural processes. English has taken approximately 500 years to develop its register of mathematics and it is still ongoing. For example, the emphasis on articulating mental strategies to solve problems in the numeracy development projects introduced into New Zealand English-medium schools in 2001 required the introduction of a range of new terms and meanings into mathematics education (Woodward & Irwin, 2005). The new mathematics terms and concepts include part-whole, tidy numbers and compensation, reversibility and place value partitioning, and advanced proportional part-whole (Ministry of Education, 2008b). These are not new words to the English language, as such, but are terms given a new or changed mathematical meaning.

While there may not be many new English-language mathematics words, the same thing cannot be said of the register. Lee (2006) noted that the

mathematics register is not static, but is constantly evolving and changing, in part to encompass new ideas and in part because of its relationship to natural language, which itself is changing and developing. For example, Tapson (2004) pointed out that, traditionally, the correct name for a polygon having nine edges was an enneagon (Greek prefix and stem), but no one uses this term nowadays. He noted that universal usage has replaced it with nonagon (Latin prefix and Greek stem) and no one seems to mind (Tapson, 2004). Tapson (2004) also provided the examples of the plurals, “formulae” and “formulas”, both of which are used widely. He added that the American-English-language way of forming plurals (formulas) is slowly gaining ground over the traditional Latin (formulae) and will probably win out in the end (Tapson, 2004). Halliday (1988) observed that, as new registers evolve, they gain value by virtue of being functional. Creating specialised mathematics terms will not by itself create a register. As teachers teach, a register is created out of this evolving, dynamic functional need.

3.8 Pedagogical Implications

A considerable body of research has identified linguistic aspects of the English-medium mathematics register that impinge on student learning, with associated pedagogical implications for the learner and teacher (Cocking & Mestre, 1988; Pimm, 1987; Schleppegrell, 2007). Identifying all the linguistic issues is beyond the scope of this study, but the discussion below illustrates some of the pertinent pedagogical concerns. Research into the learning of mathematics has consistently identified a range of linguistic structures that are used in mathematics in different ways from the language typically used in everyday life (Esty, 1992). Mathematics also consists of highly technical vocabulary and grammatical features, suggesting that, cumulatively, these forms present challenges to many students (O’Halloran, 2000; Pimm, 1987; Spanos et al., 1988).

As well as the technical vocabulary (e.g., hypotenuse), features of the mathematics register that prove challenging to the learner include dense noun phrases such as “the volume of a rectangular prism with sides 8, 10, and 12 cm” (Schleppegrell, 2007, p. 143). In the mathematics register, precision is required and particular modes of argument are valued,

including “brevity” and “logical coherence” (Forman, 1996). Additionally, there is frequent use of imperatives (“draw a diagram”), nominalisation (i.e., changing a process such as “to rotate” into a noun, “rotation”, thus creating a mathematical “object”), use of the passive structure (“a line is drawn”) or use of the more formal “we” rather than the personal “I” (“we draw a line” rather than “I draw a line”; examples from Morgan, 1998). Forman (1996) noted that one of the characteristics of mathematics language is its impersonal nature (sentences without subject) and the deletion of pronouns.

Research literature on children’s concepts of measurement, which describes learning progressions, consistently identifies a variety of linguistic structures such as comparing objects to be measured as a critical step in the learning process (Lehrer, 2003). This is consistent with a very early study by Knight and Hargis (1977), who pointed out that since mathematics is a study of relationships, linguistic comparative structures are an essential and recurring part of mathematics language. Carrasquillo and Rodriguez (1996) noted that the syntax of mathematics is often seen as the language that describes relationships. Working out these relational constructions can be difficult for the learner (Moschkovich, 1999). Other research has paid more attention to certain simple grammatical structures that can be readily identified in problems associated with the words “more” and “less” (Jones 1982; Thorburn & Orton, 1990). A number of researchers have also identified linguistic problems involving logical connectors such as “if” and “then” (Cocking & Mestre, 1988; Kessler, Quinn, & Hayes, 1985; Zepp, 1982). Logical connectors are one linguistic device used to develop and link abstract ideas in mathematics and may vary in meaning compared with everyday English (Esty, 1992). When students read mathematics problems, they must be able to recognise logical connectors and the situation signalled (Dale & Cuevas, 1987). These situations include similarity, contradiction, cause and effect and logical sequence (e.g., the hypothetical situation signalled by the connector “if” in the following sentence: “If I subtract 5 from 12, how many remain?”).

Researchers have highlighted a range of cultural and contextual (pragmatic) issues for students associated with solving mathematics problems (Crandall, Dale, Rhodes, & Spanos, 1985). If the cultural context of problems is unfamiliar, students may have difficulties interpreting the intent of the problem and subsequently solving it. That is, a student's personal experience may mismatch the linguistic expression used to state the problem (Kersaint, Thompson, & Petkova, 2009).

3.9 Indigenous Languages and Mathematics

The development and elaboration of indigenous languages in order to teach mathematics is not unique to Aotearoa/NZ. Frequently, the motivation to develop new lexicon and to expand the language register is based on concerns to do with the endangered status of the language itself. Broadly defined, an indigenous language is any language that is "native" to a particular area (Walsh, 2005). On this basis, Māori is indigenous to Aotearoa/NZ, whereas English in Aotearoa is non-indigenous, being a colonial settler language. Indigenous language issues overlap with endangered languages but are not co-extensive (Walsh, 2005). Some indigenous languages are not endangered languages. Mandarin is indigenous to China but is not an endangered language. Scholars contest, however, what counts as endangered. For example, Crowley (1998) viewed many indigenous languages in the Pacific as not being endangered. Conversely, Dixon (1991) viewed many of those same languages as endangered. The following sections focus on the issues concerned with and/or elaborating endangered indigenous languages in contexts similar to Aotearoa/NZ.

3.9.1 Early anthropological views

Long before indigenous people were recognised as a special group by the United Nations (Sanders, 1999), anthropologists had recorded mathematical practices of indigenous people, particularly counting systems. For example, Best (1907) examined the numeration system of "Neolithic Māori", and the "rudiments of modern science as observed in Māori usage" (p. 94). Crawford (as cited in Harris, 1987, p. 30) in a very early publication, demonstrated his knowledge of Australian Aboriginal

numbers by listing “the rudest numerals of the lowest savages of which we have any knowledge” (p. 30).

Interpretations of mathematically related ideas in these early studies often reflected historical issues of Western political dominance. For example, Harris (1987, p. 34), citing a 1890 ethnographic study by the researcher Haddon, noted that, even when presented with a particular mathematical practice, Haddon would not believe his own informants. Harris (1987) suggested the reason for this was the theory of evolution newly formulated at that time that lent scientific respectability to racist beliefs, including the physical, cultural and intellectual inferiority of the Aborigines. Therefore, not all anthropologists were willing to accept information from indigenous people because of preconceptions about the type of knowledge that mathematics was and the perceived level of intellectual sophistication that indigenous people could reach (Bender & Heller, 2006; Pickles, 2009).

3.9.2 Issues in elaborating indigenous languages

The focus on the “limitations” of indigenous languages and indigenous mathematics systems to express “modern Western” mathematics has continued into contemporary times, although it is not always as overtly biased as the early work. For example, Harris (1987) argues that the false notion of indigenous mathematical inadequacy has persisted in the writings of some mathematics historians and linguists, citing Von Brandenstein (1970) and Blake (1981, p. 3), who both claimed that Australian Aboriginal languages had no word for a number higher than four. Additionally, Hale (1975) proposed that in an Aboriginal language such as Warlpiri, the words “one” and “two” are in fact “indefinite determiners” rather than numbers *per se*. Harris (1982) warned that characterising Australian Aboriginal languages as non-counting might seriously misrepresent the mathematical systems and abilities of indigenous Australians. Such cultures may not have developed extensive number systems simply because they had no need for them, not because they could not do so.

More recently, there has been a range of views on whether indigenous languages can, or should, be extended into new domains of usage. One of

the more sceptical commentators, Dalby (2003), referring to attempts at indigenous language revitalisation in California, complained:

Their limited scope is all too evident. If the only words of Wiyot that you use are *yes* and *no*, and only in a particular semi-ceremonial context, this is no longer a language, any more than musicians are speaking Italian when they say *andante* and *fortissimo*. These are simply loanwords used in a special context. (p. 250)

The following section examines issues identified in the literature to do with possible limitations of the linguistic structure of indigenous languages that are in the process of elaboration.

3.9.3 Limitations of the linguistic structure

Although not universally supported, research into indigenous languages has focused on the ability (or inability) of the indigenous language to express modern (Western) mathematical concepts (see Section 3.9.6 for counter arguments). Arguing from a deficit perspective, Schindler and Davison (1985) suggested that it is very difficult, and perhaps impossible, for native speakers of Navajo to construct an exactly parallel systematic analysis of the mathematics concepts in English because of the differences in the structure of the two languages. Similarly focusing on the Navajo, Moore (1994) cited the work of Pixten, van Dooren, & Sobero (1987), who noted that the Navajo tend to stress the dynamic rather than the static aspects of reality. He contrasted this with an understanding of the concept of conservation as defined by Piaget, which is based on a belief that certain physical characteristics of an entity can remain unchanged (Moore, 1994).

If the forms and constructions of one language do not always have exact counterparts in other languages, this may suggest that the thinking processes of the speakers of one language differ from those of a speaker of any other language. As discussed earlier, the idea that the structure of a language can affect thought processes has been termed the linguistic-relativity hypothesis or Whorfian hypothesis (Harrison, 2007). The theory has received support from modern research, at least in its moderate form (cf. Section 1.4). For example, there are certain areas, such as perception of space in geometry, where some Whorfian effects have been

demonstrated by empirical investigation. Research has shown that various indigenous Australian language perceptions of space are incongruent with spatial descriptions in European languages (see Edmonds-Wathen, 2010; Levinson, 2003; Levinson & Wilkins, 2006). More general indications of the effect of culture on mathematical learning can be found in Gay and Cole's (1967) much-quoted study of the Kpelle of Liberia. According to this study, mathematical reasoning is difficult for the Kpelle because they have no use for logical patterns or for the mathematical material they learn (Austin & Howson, 1979). They (the Kpelle) have no absolute notion of "equality" and any large number is estimated (Austin & Howson, 1979).

Austin and Howson (1979) pointed out that in several languages, for example, Igbo, there is no simple word equivalent to "zero", a concept that plays a central role in most mathematics. In Yoruba, a West African language, such a word exists but there is no corresponding notation, and "zero" as such plays no part in the Yoruba number system (Taiwo, as cited in Austin & Howson, 1979, p. 8).

Finlayson and Madiba (2002) suggested that many African languages make little use of logical connectives, such as the English-language articles "the" and "a", which are common features of scientific writing in English. Graham (1988), in her study of mathematical education and Aboriginal children in Australia, posited that many languages spoken by children in developing countries lack the mathematics register—both the vocabulary and the logical connectives. Logical connectors are used to join or connect two ideas that have a particular relationship. These relationships can be sequential (time), or about reason and purpose, and are heavily embedded in Western mathematics. Hence, from this view, the presence or absence of particular logical connectives can facilitate or impede reasoning (Durkin & Shire, 1991). Berry (1985) argued that even when a mathematical register has been developed in the indigenous language, there could still be a clash between the different underlying cognitive structures of the mathematics register and the indigenous language.

3.9.4 The standardising process for indigenous languages

The English language has developed a mathematical register over several centuries. Many indigenous languages do not have the luxury of a similar time frame. So a challenge and constant debate in revitalisation programmes for indigenous languages is about what the technical principles of vocabulary development ought to be (Cobarrubias & Fishman, 1983). The debate seeks to answer such questions as whether words should be borrowed, or created through more natural language development processes such as compounding or descriptive phrases.

It was argued by the lexicon committee for Hawaii, for example, that technical scientific terms are international terms, not specifically English, and they have been mostly developed from Greek or Latin origins. So a great deal of the Hawaiian technical vocabulary consists of “Hawaiianised” borrowings, the technical terms being adapted to the Hawaiian sound system (Hinton & Hale, 2001). In contrast, when creating new words for the Alutiiq language (Kodiak Island, Alaska), Counciller (Kimura & Counciller, 2009) noted that it was considered undesirable in that particular language community to nativise (transliterate) terms unless borrowing from a related dialect or language (p. 129). Kodiak Island had been variously colonised by Russia and the United States for over 100 years and, as a consequence, the preferred option was to resurrect an obsolete term or to add definitions to an existing term rather than to borrow from the colonial language (Kimura & Counciller, 2009). In their research into the endangered indigenous languages in Western Canada, Blair and Fredeen (1995) observed that it was common in indigenous terminology creation in that community also to avoid borrowings from the dominant language. This links to the ideology of “linguistic purism”, which is discussed in Chapter 10 in relation to the development of the Māori-medium mathematics register, which has also tended to follow this approach.

Although mathematics is taught in the early years of schooling throughout the Pacific in indigenous languages, there has been no long-term strategy for the development of a specialised mathematics register. Other than Māori, the predominant strategy used in the Pacific, particularly with

Polynesian languages, has been to transliterate and/or modify phonologically the existing English-language mathematical terms to fit the native vernacular (Begg, 1991). The countries that have followed this approach include Samoa, Tonga, Niue, Rarotonga and French Polynesia (Begg, 1991).

Linked to the technical process is the issue of codification or standardisation. Although not discussing mathematical terms explicitly, Lazore (1993), when reporting to the Mohawk language steering committee, suggested that standardisation did not mean the elimination of dialects in favour of a new literary form. Dialects could be preserved in the family and in the community of speakers (Lazore, 1993).

An outcome of the standardisation process, and something that is common in Western mathematics, is the decontextualisation of mathematics. This outcome may be problematic for those involved in extending indigenous languages into new domains. For example, Lipka (1994) pointed out that one of the challenges in adapting school mathematics in the Yup'ik communities in southwest Alaska was that traditionally there were different words for the same numbers. Similarly, Denny (1981), in discussing the development of a mathematics register for Ojibway (Michigan, USA), noted the context-specific nature of quantification terms in that indigenous language. Lipka (1994) believed that decontextualising counting systems, and then making them abstract, could change the very nature of the indigenous activity, which, paradoxically, may cause unwanted cultural change in a time when cultural and linguistic maintenance was the goal.

3.9.5 Agents of change

Another important issue that has arisen in the process of elaborating the indigenous language to extend into domains such as Western mathematics, centres on concerns about who actually makes and carries out key decisions in the planning and development process. For example, is it carried out by teachers, language experts and language commissions, or by mathematicians (or some combination of the above)? Hornberger and Kendall (1996) maintained that revitalisation could only truly succeed

if the community of users is significantly involved in the development. However, in many situations, informants in LPP have traditionally come from what is referred to as “top-down” language planning situations (Kaplan, 1989). These are people with power and authority that make language-related decisions for groups, often with little or no consultation (Kaplan & Baldauf, 1997). Kimura and Counceller (2009), in their discussion of the creation of new words for the Hawaiian language, proposed that, when a language needs to be revived, new indigenous words are more likely to emerge from a more culturally and politically conscientious group of proactive L2 indigenous speakers. This view was partly in response to the difficulty older Hawaiian native speakers have had in creating new words without some requisite expertise in the curriculum areas, such as mathematics.

3.9.6 The emergence of ethnomathematics

While a reasonable corpus of research that focuses on indigeneity in mathematics education spanning the 1970s to the present exists, it generally positions indigenous students as being “the other”, because their achievement in mathematics is not the same as non-indigenous students (for a critique of this research from the Pacific region, see Meaney, McMurphy-Pilkington, & Trinick, 2008). During the 1980s and 1990s, there emerged, among teachers, mathematics educators and researchers working with indigenous students, a growing resistance to this deficit interpretation of indigenous students (Powell & Frankenstein, 1997), and the (neo)colonial prejudices (Bishop, 1990) and wider Eurocentrism this work reflected (Joseph, 1992, 1997). Such critical work has attempted to show that beyond the imported Western school mathematics, other forms of mathematics exist (Gerdes, 1985). Various concepts have been proposed to contrast the *school* mathematics (i.e., the school mathematics of the imported curriculum) with the mathematics of the indigenous colonised group. For example, Gay and Cole (1967) and Lancy (1978) criticised the education of indigenous students in “Western-oriented” schools, and proposed a creative mathematical education that used indigenous mathematics as the starting point. Zaslavsky (1979) focused on the applications of mathematics in the lives of African people and,

conversely, the influence that African institutions had on the evolution of their mathematics. Fyhn, Sara and Sriraman (2011) highlighted the traditional Sámi mathematics practices that can be used in contemporary Western mathematics classrooms, including traditional measurement concepts and traditional understanding of ratios. Ascher and Ascher (1981) studied informal mathematics, which one learns outside the formal system of education, and its potential applicability in school mathematics.

Gerdes (1985) also provided a critique of situations in which mathematical elements existed in the daily life of indigenous populations during colonial occupation but were not recognised as mathematics by the dominant colonial group's ideology of Western mathematics supremacy. To raise the status of indigenous peoples' mathematics, Gerdes (1986) endeavoured to reconstruct or "unfreeze" indigenous mathematical thinking "hidden" or "frozen" in old techniques such as basket making, which might stimulate cultural awareness in indigenous learners of mathematics. Mellin-Olsen (1986) focused on the "folk mathematics" that developed in the normal working activities of indigenous peoples and other cultural groups, which might serve as a useful starting point in the teaching of mathematics. These studies advocated the inclusion of indigenous or cultural mathematics into school mathematics on the basis that including non-Western mathematics might encourage different cultural groups or underachieving groups into a more positive engagement with Western mathematics.

Some studies have examined the relationship between mathematical activity language and thought, for example, Pixten et al. (1987) in their work on the Navajo, and Cooke (1990) on Australian Aboriginal peoples. Barton and Frank (2001) and Barton (2008) looked for examples of different mathematics in the languages itself. Barton provided the example of the Kankana-ey language (northern Philippines), in which numbers act as adjectives, rather than nouns as they do English (Barton, 2008). The various aspects illuminated by the aforementioned concepts have been

gradually incorporated over time under the more general title of “ethnomathematics”.⁵

Researchers with a more positive view of the capacity for modernisation of the lexicon and elaboration of indigenous languages have critiqued some of the earlier, more deficit-oriented work. They have argued that traditional indigenous mathematics systems are more than adequate to cope with their traditional cultural demands (Bender & Heller, 2006). For example, in their review of literature of the mathematics concepts of Native Americans, Schindler and Davison (1985) noted that researchers have highlighted the notion that, among the different groups, there was little functional use for large numbers, a feature of Western mathematics used to enumerate, measure and so on.

Additionally, Meaney et al. (2012) maintained that, in some cases, indigenous mathematics might simply have been undertaken in ways that are different from Western cultural norms and thus remain unrecognised by researchers. These researchers are predominantly European, are very few in number and, in many cases, may not have fully understood the indigenous language, collectively making such research precarious. For example, Roberts (1998) challenged the assertion by Graham (1988) that Australian Aboriginal languages do not contain logical connectors. She provided examples where logical connectives and cohesion markers do exist in the aboriginal languages in question (Roberts, 1998). Similarly, Harris (1987) highlighted that statements such as Blake’s (1981) about the limitations of Australian Aboriginal counting systems and argued that they are demonstrably false. Owen (2010) demonstrated that some cultures have many words for a mathematical idea or concept, or degrees of the concept (e.g., positioning and space), which may highlight “how limited a Eurocentric view of mathematics can be” (p. 460). Because the culture does not have a standard term, it may have encouraged a perception by European researchers that the terminology was deficient in some way.

⁵ See D’Ambrosio (1985) and, more recently, Barton (1996) for their seminal discussions on the history and development of ethnomathematics.

Pimm (1995) and a range of other researchers have highlighted the fact that words such as “cosine”, “sine” and the symbol for zero were borrowed from other languages when the mathematical ideas were first introduced to English speakers. As Austin and Howson (1979) observed, the problem is an old one and not necessarily confined to minority indigenous languages, as seen, for example, in the late arrival of “zero” on the European mathematical scene—it was not until Newton and Leibniz developed calculus in the 1600s that zero was fully understood.⁶ Many native speakers of English do not consider, or are ignorant of, the extent of foreign influence on their language, but it is considerable. It is estimated that only about 25% of the English vocabulary is actually native (Bryson, 1990). The remainder comes from French (thanks largely to the Norman Conquest), Latin and Greek (mostly from the Renaissance), and other languages (via colonialism; Bryson, 1990). Thus, while it is true that many indigenous languages did not initially have the range of terminology necessary to teach “Western mathematics”, Harris (1980) argued that these deficiencies in mathematics vocabulary could be applied at some point in time to all languages, including the English language:

History repeats itself. Where people are now wondering whether mathematics can ever be adequately taught through the medium of Australian Aboriginal languages, and many are stating the opinion that these languages are “too primitive” and mathematics can only be effectively taught through the medium of English, it is worthwhile to remember that back in the 1500s in England people had to fight hard to be allowed to teach mathematics and other subjects in English. The language of instruction was Latin, and English, which is a creole, was considered inadequate to convey the higher forms of learning. However, it was argued that if the common people could learn in their mother tongue (English) they would learn better and more of them would be able to take advantage of the education offered. (p. 2)

The difference is that while English has since developed incrementally over hundreds of years, intermittently borrowing words from other languages, this process has not been similarly accorded many indigenous languages, particularly those that are endangered such as *te reo Māori*.

⁶ See Fibonacci, building on Al-Khowarizmi's work with algorithms in his book *Liber Abaci*, or “Abacus book”, in 1202 introduced 0 into European languages, it was not until the developers of calculus, Newton and Leibniz, in the 1600s (Kaplan, 2000).

3.9.7 The development of indigenous languages: Functional perspective

Deliberate register development is not without difficulty, especially when familiar words begin to be used for mathematical purposes (Halliday, 1978). However, there is considerable research that asserts all languages have the capacity to grow and develop over time. From a functional perspective, the requirements of expressing mathematical meanings can place strains on a language and, according to Pimm (1991), this strain results in new ways of expression. Finlayson and Madiba (2002) noted that there is a substantial body of research work that shows that languages will develop through use. Additionally, according to Cooper (1989), the form (language policy) will always follow the function. From a language planning perspective, Kaplan and Baldauf (1997) contended that all languages have some mechanism for elaboration. Cumulatively, research suggests that all languages thus have the ability to develop a mathematics register to meet the demand of modern mathematics given the functional need, including indigenous languages. Crystal (2000), commenting on the impact of English on reclaimed Kaurana, an indigenous language of the Adelaide Plains in South Australia, suggested, for example:

The revived language is not the same as the original language, of course; most obviously, it lacks the breadth of functions which it originally had, and large amounts of old vocabulary are missing. But, as it continues in present-day use, it will develop new functions and new vocabulary, just as any other living language would, and as long as people value it as a true marker of their identity, and are prepared to keep using it, there is no reason to think of it as anything other than a valid system of communication. (p. 162)

3.10 Summary

This chapter has provided a critical overview of the theory of “register”, highlighting the key role of Halliday (1978) and others in the development of the mathematics register from the perspective of SFL. Halliday was concerned with describing linguistic variation in different contexts and situations. The primary construct in SFL theory for explaining linguistic variation is “register”. This chapter emphasised that discourse categorisation is a complex problem, and as a result of this complexity, there is considerable dissensus about the meanings of terms such as

“register” and “dialect”. However, over the past 20 years or so, a consistently developed methodological framework describing the register in linguistics has emerged that supports Halliday’s (1978, 1990) definition. It is widely used today in sociolinguistics and provides a useful parameter of linguistic analysis.

In English-medium education, the primary catalyst for considering the features of the mathematical register lies in research to do with the language of the learners and aspects of the register that they find challenging and thus impinge on their learning. This research has highlighted a range of linguistic features of the register that are challenging to learners and thus have considerable pedagogical implications for both the teaching (the teacher) and learning (the student) of mathematics. Studies that focused on the mathematics register were expanded to consider multilingual and indigenous language learning situations. This chapter provided a summary of the evolution of the mathematics register in English in conjunction with more recent developments to adapt the mathematics registers of endangered indigenous languages to teach Western mathematics.

A range of views exist that either question or support the development of indigenous languages in order to teach mathematics for schooling. While research has highlighted that deliberate register development is not without difficulty, a growing body of research work shows that languages will develop through use, and that all languages have some mechanism for elaboration.

Informed by an analysis of the key literature, the following two chapters, Chapters 4 and 5, provide the macro-level ecological context for the subsequent narrative of the development of the Māori-medium mathematics lexicon and register in the modern era reported on in Chapter 7.

Chapter 4. Period of Assimilation and Then (Re)⁷ Vernacularisation of *te Reo Māori*

4.1 Introduction

The development of the *pāngarau* register has not occurred in isolation, but has been influenced by historical and contemporary macro-level *te reo Māori* contextual factors. This chapter draws on literature that examines the vitality (health) of *te reo Māori* over the past 130 years using the theoretical LPP framework developed by Kaplan and Baldauf (1987) of status and corpus planning. Within these two dimensions, sociolinguistic literature is examined that critiques linguistic ideologies such as *linguistic assimilation*. This particular ideology supported the considerable *te reo Māori* shift to English in Māori communities. Cobarrubias and Fishman (1983) described assimilation as the belief that everyone, regardless of origin, must learn the politically and dominant language of society, such as English in the case of Aotearoa/NZ.

The causes of language shift in Māori communities are as complex as the history of colonisation. Because these causes have been detailed comprehensively elsewhere in the literature, they will not all be elaborated on here (see Benton, 1991, 1994; Waitangi Tribunal, 1986). It is nonetheless relevant to this study to highlight the role of urbanisation and industrialisation, and the singular role of compulsory English-only schooling policy, in promoting language loss and linguistic assimilation, from the early contact period between Māori and European up until the 1970s.

Second, this chapter draws on literature that identifies and discusses the broad macro initiatives post-1970s that supported the (re) vernacularisation of *te reo Māori* in Aotearoa/NZ. “Vernacularisation” refers here to the restoration and development of an indigenous language (Cobarrubias & Fishman, 1983, p. 65).

⁷ The parenthesis (re) has been added to vernacularisation to emphasis that during the 1800s, schooling, including the teaching of arithmetic was in *te reo Māori*. Therefore, post-1970s developments could be considered a second period of major development.

Therefore, this chapter details the outcome of the linguistic ideologies of assimilation and then (re) vernacularisation via the two dimensions of LPP theorised by Kaplan and Baldauf (2003), that is, status and corpus planning. The broad aim of this chapter is to provide a historical context to the third dimension of LPP, *te reo Māori* in education, which is considered in Chapter 6.

4.2 Status Planning: The Vitality of *te Reo Māori*

The factors that affect the maintenance or shift of a traditional language of a speech community, such as *te reo Māori*, collectively indicate the “vitality” of a language (Landweer, 2000). A number of tools to assess linguistic vitality have been developed; the most recognisable internationally is probably the Graded Intergenerational Disruption Scale associated with Fishman (1991). In sociolinguistic research, the vitality of a language can be considered by factors including status, institutional support, intergenerational language transmission, absolute number of speakers and shifts in domains of language use (Baker, 2002). While Landweer (2000) cautioned against assessing the vitality of a language according to one factor, the *status* of a language and its *speakers* is a significant determinant of whether speakers choose to speak and/or support the language (Clement, 1986).

4.2.1 Changes in political power and social prestige

When colonisation began in Aotearoa/NZ in the early 1800s, Māori and Pākehā developed ideas and beliefs about one another’s language. During the colonial period, European attitudes to *te reo Māori* would have been influenced by certain assimilationist, hegemonic beliefs and attitudes about indigenous languages (Reagan, 2009). According to Dorian (1998),

The Western language ideology of assimilation comprised a system of beliefs based on three central premises: the certainty that bilingualism is onerous; contempt for subordinated, non-standard languages and a belief in linguistic “survival of the fittest”; and a social Darwinian view of language which encouraged people of European backgrounds to assume a correlation between the adaptive and expressive capacity in a language and the potential (or otherwise) of that particular language’s survival. (p. 10)

Examinations of both overt and covert *te reo Māori* LPP in Aotearoa/NZ reveal that each of the three components of European linguistic ideology as outlined by Dorian (1998) was clearly present. Examples are provided throughout this chapter.

When Europeans first arrived in Aotearoa, *te reo Māori* served as the language of wider communication for some time—a lingua franca between Māori and Pākehā. In these initial encounters it was the Europeans who made an effort to learn *te reo Māori* because in many cases their survival in the new environment depended on it (Belich, 1996). As the years passed, Europeans became established in the new country and gained political control, and through both overt (English-language-only schooling policy) and covert (English-language-only workplaces) action ensured the dominance of the English language (Chrisp, 2005). As a result, the English language gained prestige, quickly taking over as a language of wider communication and as the dominant language of Aotearoa/NZ. This development also probably ended any hopes of Aotearoa/NZ becoming a pluralistic society, demonstrated by the ongoing dominance of English to the present day (May, 2012). LPP strategies that aim for pluralism support the “coexistence of different language groups and their right to maintain and cultivate their languages on an equitable basis” (Cobarrubias & Fishman, 1983, p. 65), something demonstrably lacking from English-dominant contexts (May, 2012).

4.2.2 Te reo Māori status: Economic and demographic factors

Language choices are influenced, consciously and unconsciously, by social changes that disrupt the community in numerous ways, and include external pressures or “dislocations” (Fishman, 1991). Dislocations can be divided into different categories, including economic, social and demographic (Fishman, 1991). One significant demographic factor in Aotearoa/NZ was the migration of Māori from rural to urban areas (Benton, 1991; May & Hill, 2005). During the 1800s and early 1900s, most Māori people lived in linguistically isolated rural communities where *te reo Māori* was the principal language (Fishman, 1991). Once migration of rural people to urban areas occurs, there is an increased chance of the minority language losing its everyday communicative functions (Baker & Jones,

1998). In industrialised nations, the dominant language in the office and the factory is more likely to be the majority language, with the minority language being devalued and/or ignored. In rural areas, the language of work and cultural activity is more likely to be the historical language of the area and of daily interactional use (Baker, 2011). This is exemplified in Benton's (1991) seminal research showing *te reo Māori* to be strongest in the isolated rural communities of Aotearoa, for example, Bay of Plenty (Tuhoe iwi), Northland (Te Rarawa iwi) and East Coast (Ngāti Porou iwi). While these isolated rural communities were, in general, more resistant to the pressures that caused language shift in other areas of Aotearoa/NZ, ultimately, even these communities were not immune, particularly when faced with English-only schooling policies (Harlow, 2007). This was also the case in relation to my own personal experiences in such a community (see Chapter 1).

From the 1950s onwards, the Māori population rapidly became urbanised⁸ in response to economic and social struggles in rural areas (Benton, 1991). Of significance was a series of explicit social, educational and employment policies related to a wider economic drive for a larger labour force, generally to be located in towns and cities (Barber, 1986). Once Māori migrated to urban areas, there was a greater likelihood of Māori mixing with English-language speakers in most (if not all) workplaces, as English was the only language permitted (Chrisp, 2005).

The external forces of industrialisation, urbanisation and overt and covert LPP created internal forces that inevitably discouraged Māori families from speaking *te reo Māori* to their children or grandchildren (Ratima & May, 2011). As Ratima and May (2011) noted, sometimes parents decided not to speak their L1 to their children because they perceived an economic or educational advantage for their children in talking the "other" language, English. Many Māori, including my grandmother (see Chapter 1) and others of her generation from working-class backgrounds, believed opportunities for employment and commerce would be open only to those fully proficient in the dominant language, English. It was not that they did

⁸ In 1956, the majority of Māori (76%) lived in rural areas; by 1976, 78% of Māori lived in urban areas (King, 2007).

not support the learning of *te reo Māori*, but the belief that English-medium education was important for their children and grandchildren for employment was by then pervasive. By speaking only in English at home, they believed they were supporting the acquisition of English by their children and grandchildren, thus optimising opportunities for future work and careers. While it is understandable that Māori thought this way, in reality, the factors behind economic disadvantage were not necessarily linguistic. As May (2003) pointed out, lack of knowledge of the dominant language is not the only reason for being stuck on the lower rungs of the socio-economic ladder. Minority groups have faced the wider issue of structural disadvantage, including racism and discrimination (May, 2005). All Māori now speak English, and for the vast majority, it is their L1, but socio-economically, Māori are still disproportionately disadvantaged (Cram, 2012).

The socio-economically disadvantaged status of Māori, a minority group in Aotearoa/NZ since the 1900s, has been a key element in determining overall *te reo Māori* vitality (de Bres, 2008) and supporting linguistic assimilation. Such a view is consistent with international research by Baker and Jones (1998), who found that the vitality and, consequently, the status of a language is often determined by the socio-economic status of its speakers. While this may suggest a rather instrumentalist function for the learning of *te reo Māori*, experience shows that effective LPP is bound to fail, if elevating a vernacular—for example, an indigenous language, as is the case here—to an instructional language in education does not also support people's economic standing (Kaplan & Baldauf, 1997).

4.2.3 Social status of *te reo Māori*

The social status of a language, that is, its prestige value, is closely related to the economic status of the language, and is also a powerful factor in language vitality and, conversely, in promoting linguistic assimilation to the dominant language (Baker, 2011). In the Aotearoa/NZ context, when a majority language such as English is seen as giving higher social status and more political power, the shift to English from Māori is exacerbated. Attitudes towards language are strongly influenced by attitudes towards people (Skutnabb-Kangas, 1981). If people such as

Māori have little power and low prestige, their language is unlikely to be well thought of by others (Boyce, 2005; Dorian, 1998). Holmes (1999), in his study of attitudes towards Māori, found that most people rated Māori lower than Pākehā on a number of variables, particularly status in regard to income, education, social class and intelligence. He suggested that reducing these negative attitudes requires the achievement of greater equity between Māori and Pākehā, thus promoting more positive views of the Māori language (Holmes, 1999). However, this is not likely to happen soon, as research into current perceptions of Māori in the media reveal that the image portrayed of Māori is still negative (Nairn et al., 2012).

The following section examines the second dimension of LPP in relation to *te reo Māori*—corpus planning. The modernising of the arithmetic terminology for everyday functional use will be used to exemplify the transition of *te reo Māori* from an oral to a written language (graphisation), and to provide a contrast with the strategies used to develop the *pāngarau* lexicon, post-1980s.

4.3 Corpus Planning in Aotearoa Pre-1980s

In Kaplan and Baldauf's (2003) model, corpus planning activities are grouped under the three main subdimensions of graphisation, grammatication and lexication. Two of the three main types of corpus planning—graphisation and modernisation—are evident in the development of *te reo Māori* dating back to the 1800s; however, any conscious language planning prior to the 1980s can be considered only with respect to graphisation and some orthographic work (Harlow, 2005).

4.3.1 The beginnings: Graphisation and standardisation

The following sections organise the LPP activities of graphisation and standardisation into three broad periods, focusing on arithmetic. First, there is the initial contact period between Māori and European whalers and traders around the turn of the 19th century, in which the Māori number system was initially standardised and the change began from solely an oral form to a print form. Second, from the 1820s onward, there is the work of the missionaries, who played a significant role in standardising *te reo*

Māori orthography. And third, there is an examination of general *te reo Māori* development post-1860s.

4.3.2 The era of whalers, sealers and traders

From 1790 to the 1820s, Aotearoa/NZ was colonised by European whalers, sealers and traders, predominantly from Britain. Attempts were made very early on in this contact period to develop what had previously been an oral mode of mathematics for Māori into a printed form (Trinick, 1999). The reasons were initially economic—to trade in commodities such as whale oil, guns, food and flax. In 1793, Lieutenant-Governor Philip Gidley King of New South Wales visited the North Island and collected information relating to the country and Māori, essentially to better inform Europeans (Best, 1921). This information was published in Collin’s *History of New South Wales* (as cited in Best, 1921, p. 249). *Te reo Māori* numerals were misspelt by today’s spelling conventions but nonetheless recognisable: Ta-hie [Tahi]—one, Du-o [Rua]—two, Too-roo [Toru]—three . . .

This publication was followed by Dr John Savage’s (1807) publication of a Māori language vocabulary. Savage’s intent was to enable European visitors to Aotearoa to better communicate with Māori (Trinick, 1999). Following are some number examples from his book (Savage, 1807):

Cotidi	ka tahi	one
Cadooa	ka rua	two
Ngahoo-de	ngahuru	ten
Cattekow	ka [rua] tekau	twenty (p. 80)

In the early 1800s, Europeans attempted to come to grips with *te reo Māori*, and Māori with the English language. While there was no standard *te reo Māori* orthography, Jones and Jenkins (2011) have shown that, during the early 1800s, Māori observed that the written text carried considerable authority among Europeans. Māori quickly utilised this new form of communication to establish and confirm their own *mana* (authority), by asking Europeans to write testimonials and ownership certificates in English even though they could not read themselves (Jones & Jenkins, 2011).

In the early contact period, most Māori concepts of quantification, which had been very context specific, were decontextualised and standardised, primarily to enable trade between Māori and European (Trinick, 1999). For example, when traditionally counting *kumara* (sweet potato), a vital staple food, particularly in the North Island, Māori used a binary system (Best, 1906). The sorts of counting sequences used traditionally by Māori, such as vigesimal (counting in 20s), were often regarded by anthropologists as earlier steps in the evolution from pre-mathematical conceptions to greater abstraction (e.g., Best, 1906). In contrast, Bender and Heller (2006) strongly argued that these systems were based on functional need, and base systems such as the vigesimal were cognitively advantageous for mental calculations because they use larger counting units.

4.3.3 Codification of *te reo Māori*: The missionary period 1810–1840

The early European traders, whalers and sealers were eventually joined by missionaries, who initially settled in the north of Aotearoa/NZ (Simon, 1990). They had a different motive for coming to Aotearoa than the traders: to spread the gospel and civilise the natives (Barrington & Beaglehole, 1974; Simon, 1990). The first European missionaries, finding Māori had no written language, began to formulate their own written *te reo Māori* (Binney, 1968), and thus became the principal LPP agency of that era.

The missionaries' first attempt at the graphisation of *te reo Māori* was a small spelling book, *A korao no New Zealand*, containing terms collected by Kendall (1815), a missionary who had arrived in the Bay of Islands in the North Island in 1813 (Jones & Jenkins, 2011). As part of his role as a missionary schoolteacher, Kendall was instructed to standardise *te reo Māori* in written form, even though he was not a trained linguist (Jones & Jenkins, 2011). Following are some attempts at writing Māori numerals in Kendall's (1815) text:

Kadooda	[ka rua]	two
Ka-toodoo	[ka toru]	three
Kangahahoodoo mati	[ka ngahuru ma tahi]	eleven (p. 43)

Kadooda contains the letter “d”, which is not a phoneme in *te reo Māori*. Although spelt slightly differently—beginning with a “k” rather than a “c”

like Savage's (1807) early attempt—the verbal marker *ka* is still evident and *ngahuru* (ngahahoodoo) to denote “ten” is still being used.

Kendall subsequently went to London with the express purpose of printing books for the missionary schools (Jones & Jenkins, 2011). Accompanied by chiefs Hongi Hika and Waikato, he collaborated with Professor Lee of Cambridge University to publish a grammar book of *te reo Māori* under the title of *A Grammar and Vocabulary of the Language of New Zealand* (Kendall & Lee, 1820). Following are selected examples of the *reo Māori* numerals (Kendall & Lee, 1820):

Ko tahi	[ko tahi]	one
Ka dua	[ka rua]	two
Kotahi te kau	[Kotahi tekau]	ten (p. 17)

Even though some of the numerals are still misspelt, Jones and Jenkins (2011) suggested that Kendall and Lee's (1820) work established the *reo Māori* orthography as it is used today. This also appears to be the first time *tekau* for “ten” appeared in any printed form. Prevalent in the very early accounts of Kendall (1815) and others is the use of the verbal marker *ka* when enumerating, which supports the view of linguists Bauer (1997), Biggs (1969), Waite (1990) and, more recently, the mathematics educator Barton (2008), that *te reo Māori* numbers possessed verb-like qualities distinct from English, in which numbers are either adjectives or nouns depending on the usage.

Interest in languages and Māori culture were not the primary reasons for developing these descriptive grammars in the early 1800s. Hovdhaugen (1995) argued that early explorers, traders and missionaries considered Polynesian languages, such as Māori, to be primitive languages, and they developed orthographies and learnt the language not out of interest in the language *per se* but because they were motivated by other imperatives. In the first grammar of Māori in New Zealand, published in 1880, the reason for writing the grammar and the choice of structure is clearly indicated in the preface:

The other particular object of the work (besides developing a Māori language orthography) is the instruction of the European Missionary

in the Language of New Zealand: whereby he may be able to communicate the blessings of Christian Instruction and Civil Improvement. (Kendall & Lee, as cited in Hovdhaugen, 1995, p. 109)

Binney (1968) also highlighted that, by 1830, 15 years after Kendall and Lee's (1820) book, missionaries had acquired enough knowledge of *te reo Māori* to enable translations of the scriptures to be used in missionary schools. Binney (1968) further added that, at first, printed material in *te reo Māori* was largely limited to religious content. The exceptions were in relation to a few settler government declarations and numeracy material for use in these early mission schools (Williams, 1975a).

The demand for more printed material hastened the development of *te reo Māori* as a written language, in part fuelled by Māori themselves (Jones & Jenkins, 2011). In some cases, Māori were motivated to develop their knowledge of the scriptures, and in other cases, they sought to write in order to communicate with the modern political and economic world of those times (Jones & Jenkins, 2011). While some Māori learnt to read with missionary assistance, others taught each other to read (Jenkins, 2000; Simon, 1990). In order to trade using Western commercial practices, a standardised concept of quantity was required (Trinick, 1999). The development of written text in *te reo Māori* also hastened the integration by Māori of Western numeracy conventions, for example, the standard algorithms used in the missionary schools during that period for adding, subtracting, multiplying and dividing (Trinick, 1999).

In 1842, a more comprehensive descriptive grammar text for *te reo Māori* was published by Maunsell, a member of the Church Missionary Society who had lived in the Waikato area since 1836 (Williams, 1975a). The spelling of numerals had improved considerably from King's attempt in 1805, for example, *kotahi* (one), *e rua* (two), *e toru* (three), and *e wha* (four). In Maunsell's (1842) text, the verbal particle *e* had replaced the verbal particle *ka* used in the earlier texts. Following Maunsell's (1842) publication, William Williams published the first comprehensive *te reo Māori* dictionary (see Williams, 1852, 1975b). After many reprints and revisions, the Williams dictionary has since become the standard reference to classical *te reo Māori* in modern times (Duval, 1995).

The early contact period saw an influx of completely new loanwords and concepts (including numerical) into *te reo Māori*, at first for trading goods and then for religious concepts (Benton, 1991). The development of the modern *te reo Māori* mathematics lexicon and numeracy system can be seen in these early historical writings: primarily, the change from a multi-base, item-specific counting system, verbal in nature, to a standardised (also multi-base) Western arithmetic system (Trinick, 1999). The translation of Western numeracy into *te reo Māori* appeared very early and helped develop *te reo Māori* into a written form (Trinick, 1999). However, it became clearer over time that becoming literate did not provide the authority Māori sought among Europeans (Jones & Jenkins, 2011).

In the process of developing a standard Māori orthography, the quantification system was further standardised to be more like the British imperial system (Trinick, 1999). While maintaining traditional Māori terms for enumerating, such as *tahi*, *rua*, *toru*, *wha* . . . , new terms were borrowed and transliterated (see Williams, 1975b, for a list of loanwords) to enable Māori to understand and use the imperial measure system (called imperial due to its origins in the British Empire; Trinick, 1999).

4.3.4 The adaption of *te reo Māori* 1800–1980s

While *te reo Māori* was excluded from schooling, it was still nurtured throughout the 19th and 20th centuries in largely Māori rural communities (May & Hill, 2005). The arrival of the European in the 1800s signalled the start of the language adaption process of *te reo Māori* (vernacularisation) to cope with the new challenges that accompanied colonisation and linguistic globalisation (Trinick, 1999). The “adaption process” of a language may involve the ‘modernisation’ of vocabulary and grammatical rule changes to allow the language to express new communicative functions, new technologies and, often, new political goals (Cooper, 1989, p. 32). The third subdimension of corpus planning, the standardisation of *te reo Māori*, was confined to the standardisation of the orthography by the early missionaries (Harlow, 2007).

4.3.5 Process of introducing loanwords

The expansion of *te reo Māori* arithmetic terms outside of schooling continued from the 1860s to the early 1900s, primarily as print culture, and its attendant literacy, became more prolific, as letters to government ministers and Māori newspapers attest (Curnow, 2002). For example, *te reo Māori* newspapers and periodicals had become part of the daily and weekly information and dissemination of advertising and commerce (Trinick, 1999). Numerical information in its various forms would not have been published if the intended audience, Māori, did not understand it (Trinick, 1999). These newspapers served a range of interests, including the settler government, church, commerce and various Māori tribes (Curnow, 2002). Because this early print literature was mainly for public dissemination, many editors and contributors used the opportunity to inculcate Māori (and Pākehā) into European habits of industry and capitalist practices (Trinick, 1999).

The actual process of borrowing words is complex and involves many usage events (i.e., instances of use of the new word; Haspelmath, 2009). Usually some speakers of the borrowing language know the source language as well, or at least enough of it to utilise the relevant word (Poplack, Sankoff, & Miller, 1988). In Māori communities, the process of adopting words from English into *te reo Māori* began from the earliest contact with non-Māori. Up until the 1980s, the predominant process of creating new Māori words was to “borrow” English or, in limited cases, French words⁹ (Benton, 1991). Arguments exist over the definition of “borrowed” or “loan” words (Yan & Deng, 2009). Some researchers consider all imported or coined words for new objects, ideas and experiences “loanwords”; these include hybrid, phonetic and semantic loans (Yan & Deng, 2009). In contrast, the definition of “loanword” used in this thesis is that promoted by Haugen (1950, 1968) and others, and built on by Duckworth (as cited in Winter-Froemel, 2008, p. 160). To paraphrase Duckworth’s definition, loanwords are words borrowed from a foreign language and transliterated (i.e., given a Māori spelling), and

⁹ This is because of the early limited French presence in NZ, primarily restricted to settlements at the top of the South Island.

“coined words” are words that may have been present in the indigenous language, but have had their meaning expanded or changed to represent the foreign meaning. For the purposes of this thesis, it is useful to differentiate between the various types of borrowed terms used traditionally and in modern times, because the decision about which strategy to use to develop terms is often determined by a community of speakers’ (current) linguistic beliefs and ideology (see Chapter 9 for further discussion on why the strategies of coining terms changed in the 1980s).

Prior to the 1980s, the types of *te reo Māori* loanwords (see Moorfield & Paterson, 2002) initially included the following:

1. The most common strategy was direct loanwords whereby words underwent phonological and orthographic changes (transliterating) to sound Māori and were often modified in meaning as well. There was a requirement for words for items traded like nails (*nera*), calico (*kareko*), cask (*kaho*), waistcoat (*wekotī*) and trousers (*tarau*).
2. Sometimes the new loanword replaced the traditional word; for example, the traditional word for measure (*ine*) was replaced by a transliteration (*meiha*).
3. Some loanwords were used extensively with multiple meanings. The word *pukapuka* could indicate any communication that used paper as the medium, including the most common, “book”, but also letter, roll, petition, manuscript, document and so on.
4. Pseudo-loanwords (coined terms) were also created by derivation from a combination of existing words. For example, there were a number of terms required for trade (including advertising), *whakawatea i taku toa* (clearance sale for my shop), *mō te utu iti rawa* (for cheapest price). These are traditional Māori words that have been elaborated to represent new economic concepts. Moorfield and Paterson (2002) identified at least 9,214 loanwords used in Māori language newspapers. However, it is debatable whether all of these words were in common daily usage by Māori.

In a number of cases, the articles were initially written in English by European editors and then translated into *te reo Māori* by Māori translators (Trinick, 1999).

4.4 Consequences of the Low Status of *te Reo Māori*

The effects of language and education policies on language among Māori and New Zealand citizens are clearly evident. May (2005) highlighted that, by the 1960s, Aotearoa/NZ was one of the most linguistically homogeneous countries in the world. The negative factors affecting the status of *te reo Māori* pre-1980s significantly outweighed the positive. The change in the status of *te reo Māori* from an initially high-status language of early colonial communication into a low-status language in Aotearoa had contributed considerably to language shift to English in the Māori community (Harlow, 2005). One of the outcomes of this process was that, by the 1970s, only about 70,000 Māori, or 18% to 20%, were fluent *te reo Māori* speakers, and most of these were elderly (Benton, 1979). Less than 5% of Māori schoolchildren could speak *te reo Māori* (Benton, 1979).

After decades of policies that promoted linguistic assimilation, by the 1970s, the primary domains for the use of *te reo Māori* were restricted to the marae and church (Benton, 1979). Researchers at the time described the Māori language as an “endangered language in a perilous state” (Benton, 1979, p. 23). It was in the 1970s that the seeds of discontent were sown (Harlow, 2005), leading to the language revitalisation movement discussed in the following sections and in the next chapter.

4.5 Shift to (Re) Vernacularisation: *Te Reo Māori* as an Official Language

Up until the 1980s, the government of Aotearoa/NZ had demonstrated little legislative interest in recognising and developing an explicit language policy to promote the indigenous language of the country (May & Hill, 2005). Covert language policy was clearly accepting, if not positively encouraging, of the eventual extinction of the Māori language, as can be seen in the infamous Hunn Report of 1960, which declared the Māori language “a relic of the past” (Hunn, 1960; see also Chapter 6 of this study). But this linguistic situation was about to change in the 1970s and

early 1980s (King, 2007). A groundswell of change was afoot in Aotearoa/NZ, largely driven by the younger generation of urban Māori disenfranchised from their language and culture, to revitalise and raise the status of the language (King, 2007).

Influenced by civil rights movements worldwide, activist groups such as Ngā Tamatoa and Te Reo Māori Society, were galvanised in the 1970s to protest, to lobby and petition the state, demanding a greater role for *te reo Māori* in government, the media and other public institutions controlled by the government (King, 2007). Despite a 30,000-signature petition presented to the government by Ngā Tamatoa in 1972 for the inclusion of *te reo Māori* in primary and secondary schools, there was minimal reaction by the then government and its state agencies (Harlow, 2007). *Te reo Māori* was offered in some primary schools with high Māori student rolls, and the government amended the Māori Affairs Act in 1974 to recognise *te reo Māori* as the “ancestral language of Māori” (Fishman, 1991). Fishman (1991) called the Act mere tokenism, with no strategy or resource for how this “recognition” might be carried out. It was clear to *te reo Māori* activist groups such as Te Reo Māori Society and Ngā Tamatoa, as well as to various individuals, that more sweeping and meaningful legislation was required (Harlow, 2007). As noted above, these groups consisted primarily of young urban individuals dislocated from their *te reo Māori* and culture, their families having migrated from their villages to the cities as part of the post-Second World War urbanisation process (King, 2007).

In the mid-1980s, another urban Māori group, Ngā Kaiwhakapūmau i te Reo Māori (The Wellington Māori Language Board), brought a claim (Wai-11) before the Waitangi Tribunal, arguing that the Crown had failed to protect *te reo Māori* and such a failure was a breach of the Treaty of Waitangi (Harlow, 2007). The Treaty of Waitangi is a treaty that was first signed on 6 February 1840 by representatives of the British Crown and various Māori chiefs from Aotearoa/NZ guaranteeing Māori certain rights (Orange, 1989). The Waitangi Tribunal was established under the Treaty of Waitangi Act 1975 as a permanent commission of inquiry; it can be considered the New Zealand Government’s first comprehensive response to over 130 years of Māori protest about Crown breaches of the Treaty of

Waitangi (Hayward & Wheen, 2004). A decisive breakthrough came when the Waitangi Tribunal found in support of the Wai-11 claimants (Waitangi Tribunal, 1986), stating that, under Article 2 of the Treaty of Waitangi, *te reo Māori* was a *taonga* (treasure) and that:

The Crown did promise to recognise and protect the language and [...] that promise has not been kept. The “guarantee” in the Treaty requires affirmative action to protect and sustain the language, not a passive obligation to tolerate its existence and certainly not the right to deny its use in any place. (p. 1)

The tribunal recommended that *te reo Māori* be used in the courts and all dealings with government; a body be established to foster the use of *te reo Māori*; an inquiry be instituted to ascertain better ways of ensuring that Māori students could learn *te reo Māori* at school; more be done in regard to broadcasting in *te reo Māori*; and Māori–English bilingualism in the public service be fostered (Waitangi Tribunal, 1986). In 1987, in compliance with the tribunal decision (one of the few by the government), the Māori Language Act was passed, declaring *te reo Māori* an official language of Aotearoa/NZ, thus supporting efforts to shift away from assimilationist policies to “vernacularisation”. The ideology of linguistic assimilation is based on the assumption that linguistic (and presumably cultural) unity is necessary (Reagan, 2009). In contrast, vernacularisation here refers to cases in which an existing indigenous language is adapted and used as a fully functioning vernacular language in all areas of life (Cobarrubias & Fishman, 1983, p. 65).

While (re) vernacularisation provided the impetus leading to significant changes in *te reo Māori* policy, including education in the modern era, May (2003), Harlow (2007) and others have observed that legal recognition of the language was still somewhat limited. For example, the 1987 Māori Language Act did not extend the right to use or to demand the use of *te reo Māori* in the public domain beyond the oral use of the language in courts of law and some quasi-legal tribunals (Benton, as cited in May, 2002, p. 31). However, the Act led directly to the establishment of Te Taura Whiri i te Reo Māori (The Māori Language Commission), the agency expected to play a significant role in the revitalisation of *te reo Māori* (discussed further below).

The passing of the 1987 Māori Language Act was not universally supported, reflecting the ongoing antagonism of many Pākehā New Zealanders to any state sponsorship of *te reo Māori* (Kāretu, 1995). Kāretu (1995) noted that, while many Māori felt the legislation did not go far enough, there were far more New Zealanders who believed the government, just by its acknowledgement of the other language of Aotearoa/NZ in its statutes, went too far. He observed that since the passing of the Act, there had been opposition to its active promotion, and its use in the media and in public places. Kāretu provided examples of his experiences, as a *te reo Māori* speaker and former commissioner of Te Taura Whiri (The Māori Language Commission), of open hostility to the promotion of *te reo Māori*, and considered this to be symptomatic of the thinking of the majority of New Zealanders at that time.

4.6 Status Planning of *te Reo Māori*—Post-1980s

Before the 1990s, there was no one organisation responsible for *te reo Māori* LPP and/or for addressing the issues of the status of *te reo Māori* (Harlow, 2007). It can be argued that, since the introduction of the Māori Language Act in 1987, *te reo Māori* planning and policy has had more direction. Notably, the Act provided for the establishment of Te Taura Whiri (Māori Language Commission). Te Taura Whiri seemed to have modelled itself on language academies in countries with a strong national language (May, 2003). These language commissions have very similar goals, including promoting the status and terminology development of their respective languages. The Māori Language Commission was set up to include a board of five members and chief executive officer with about 20 staff members. Faced with a diminishing pool of *te reo Māori* speakers, the commission was charged with “promoting Māori language as a living language and as an ordinary means of communication”, to undertake or commission research, publish information relating to the Māori language and report to the Minister of Māori Affairs on these matters (Kāretu, 1995, p. 210). The commission’s broad language goals (Māori Language Commission, 2008) attempted to ensure that:

- A range of active, self-sustainable Māori language domains exist;

- *Te reo Māori* is an everyday language of interaction in homes and communities;
- Traditional and contemporary *reo Māori* is maintained in an authentic cultural and linguistic framework;
- The people of Aotearoa recognise the intrinsic value of *te reo Māori*;
- *Te reo Māori* acquisition is supported and fully promoted through national education, broadcasting, culture, heritage, creative and information technology industries and networks. (p. 11)

Not until 1991 was the second government agency charged with supporting *te reo Māori*, Te Puni Kōkiri (formerly the Department of Māori Affairs), established by the Ministry of Māori Development Act 1991 (de Bres, 2008). It was also entrusted with some responsibility for monitoring the status of *te reo Māori* (reports discussed below). In its newly defined role, Te Puni Kōkiri was to undertake research, manage projects and provide advice to other agencies that supported *te reo Māori* regeneration work (de Bres, 2008). More broadly, Te Puni Kōkiri, as the Ministry for Māori Development, leads Māori public policy and advises the Minister of Māori Affairs, government and government agencies on policy affecting Māori wellbeing (de Bres, 2008). Te Puni Kōkiri has not been immune to criticism. For example, through the mainstreaming process (whereby Māori services are spread around various government agencies), Te Puni Kōkiri's role has been limited to policy advice, with the implication that this is a diminished and less influential role (Cheyne, O'Brien, & Belgrave, 2008).

4.7 Development of a Māori Language Policy

Despite concerns raised by Māori language activists about the state and health of *te reo Māori* in the 1970s, it was not until the mid-1990s that the first comprehensive Māori language strategy, *Toitū te Reo: A Consultation Document about the Māori Language* (Māori Language Commission, 1996) was released. Initiated by Te Taura Whiri (Mathews & Jenkins, as cited in Spolsky, 2005, p. 76), its aims were to ensure *te reo Māori* would remain the principal language of a significant number of people in Māori

domains, continue to be spoken by different generations and be accepted in non-Māori domains within a wider development of positive attitudes towards the language (Spolsky, 2003). According to de Bres (2008), however, *Toitū te Reo* was light on proposing practical actions the government could take in promoting language regeneration, instead focusing more on gathering feedback from Māori on their views on the issues and possible actions and priorities in regard to the language. Te Puni Kōkiri, the other state agency responsible for raising the status of *te reo Māori*, eventually took over development of the Māori Language Strategy from Te Taura Whiri and submitted a revised consultation document to Cabinet in 1996 (Spolsky, 2005). The Cabinet resisted the release of the revised consultation document, concerned that objectives identified in it were not achievable (de Bres, 2008). Despite some amendments, the government never formally approved the document (de Bres, 2008).

Between 1997 and 1998, Te Puni Kōkiri released a series of Māori language policy objectives, including the need to foster among Māori and non-Māori positive attitudes towards, and accurate beliefs and positive values about, the Māori language (de Bres, 2008). These policy objectives and policy development areas collectively made up the government's Māori language strategy at that time and were eventually released in 1999 in the form of the document *Te Tūāoma* (Te Puni Kōkiri, 1999). The purpose of the document was to identify areas where language revitalisation efforts required further work and increased effort (Te Puni Kōkiri, 1999). In one sense, the Māori language strategy as stated in *Te Tūāoma* was more practically oriented than that of *Toitū te Reo*, in that it was firmly focused on what the government could do within the existing functions of government (de Bres, 2008). In another sense, though, it could be seen as a step backwards. Unlike subsequent policy development, its focus was very strongly on the government sector and not the general populace (de Bres, 2008).

By 2003, one of the key Māori language strategies developed by Te Puni Kōkiri and Te Taura Whiri was to shift *te reo Māori* to the next stage of revitalisation by focusing on greater Māori language use in *whānau* and

community settings (Te Puni Kōkiri, 2003). This purpose reflected a change from earlier versions of the strategy, and partly explains Te Taura Whiri's decision at that time to sever its involvement in corpus planning for schooling. This change in strategy is discussed further in Chapter 8.

4.8 Māori Language Surveys and Reports

A number of studies into the vitality of *te reo Māori* were carried out from the late 1980s through to 2008 (see Boyce, 2005; Brown, Cullinane, Reid, & Vernon, 1990; Te Puni Kōkiri, 2003, 2008). In general, the findings were similar; Māori attitudes towards *te reo Māori* were positive. On one level, this was good news because sociolinguists argue that positive attitudes and accurate beliefs about a language contribute significantly to the ability of minority languages to co-exist and prosper alongside majority languages (Grin & Vaillancourt, 1998). However, one of the limitations of these attitude surveys is that positive attitudes towards *te reo Māori* have not always translated into correspondingly positive action by Māori to speak *te reo Māori* (Bauer, 2008). For example, there is a considerable discrepancy between those who have positive attitudes towards *te reo Māori* (94%) and those who rate their proficiency as “well or very well” (14%), in both the 2001 and the 2006 censuses (see Te Puni Kōkiri, 2008, p. 19).

Pākehā (European New Zealanders) were happy for Māori to speak *te reo Māori* at the marae and at home, but only in Māori domains and not in the public domain (Te Puni Kōkiri, 1998, 2003). Second, the majority of Pākehā did not support the promotion of *te reo Māori* on a national scale (Brown et al., 1990). Research shows that the attitudes of non-Māori New Zealanders towards *te reo Māori* are considerably less positive than those within the Māori community (Te Puni Kōkiri, 2002), and are, at times, even actively hostile (Harlow, 2005). The earlier linguistic hegemonies of imperialism and colonisation are still very much alive. Because language is also often associated with ethnicity, fostering national integration is usually seen as de-emphasising *te reo Māori* and promoting English.

Two significant reports have been released recently on the state of *te reo Māori*: the Wai 262 report (Waitangi Tribunal, 2010) and *Te Reo Mauriora*

report (Te Paepae Motuhake, 2011). Both reports raise concerns that *te reo Māori* is still in a precarious state, despite language revitalisation efforts over the past 30 years. *Te Reo Mauriora* goes further and argues that, in light of the statistics concerning the use of *te reo Māori* in households with children, *te reo Māori* would fit somewhere between “endangered” and “severely endangered”, according to Fishman’s (1991) intergenerational transmission measure (Te Paepae Motuhake, 2011, p. 17).

Both reports also highlight trends of decreasing enrolments in *kōhanga reo* and Māori-medium education programmes since the late 1990s (after their advent in the early 1980s; see Chapter 6 for further discussion). There are few explanations offered as to why there has been a decline in these two forms of language revitalisation initiatives. Both reports direct much of the blame towards government policy and implementation; and *Te Reo Mauriora*, in particular, voices concerns that Te Taura Whiri is not functioning as it should. It proposed a new structure¹⁰ to manage *te reo Māori* planning efforts (Te Paepae Motuhake, 2011).

4.9 Summary

The language planning processes and their implementation in Aotearoa/NZ have been influenced over time by a range of political, social, demographic, economic, historical and linguistic factors. As a consequence, Aotearoa/NZ has progressed through a number of language policies underpinned and promoted by a range of ideologies and beliefs about language, in particular, linguistic assimilation of *te reo Māori* and then its (re) vernacularisation.

While there was minimal, if any, corpus development for schooling, this chapter shows that the elaboration of *te reo Māori* was not a modern phenomenon. Initially, there was considerable corpus expansion of *te reo Māori* into new domains (agriculture) and functions (trade; May & Hill, 2005). The Church Missionary Society, along with individual Māori contributors, assumed the role of the LPP agency in this early contact period, in the graphisation of *te reo Māori* (transforming an oral language

¹⁰ A new language planning agency, primarily controlled by the various tribes.

into a written language). The principal form of creating new terms was by coining, that is, giving English-language words a *te reo Māori* phonology.

At the time of early contact, when the English language did not threaten *te reo Māori*, Māori were not too concerned about keeping the language “pure”. Europeans also needed to learn and speak some *te reo Māori* in order to trade, and to educate Māori in the missionary schools. *Te reo Māori* remained the language of Māori communities for decades in spite of colonisation, but slowly, changes in the demographic balance, in the patterns of settlement and in the process of acculturation led to its attrition, particularly post-Second World War.

Research that showed that *te reo Māori* was in a parlous state by the 1970s was a significant catalyst that encouraged macro-level political agitation by Māori groups to assert their linguistic rights so as to convince the government and its agencies to support the revitalising of *te reo Māori*. Initially, there was some tokenistic tinkering of the Māori Affairs Act, but not until the Waitangi Tribunal declared that the Crown had failed to protect *te reo Māori* was there a meaningful governmental response. In 1987, in compliance with the tribunal decision, the Māori Language Act was passed, declaring *te reo Māori* to be an official language of New Zealand and signalling a change in direction away from solely assimilationist policies to (re) vernacularisation.

Even though legal recognition of the language was still somewhat limited, the 1987 Māori Language Act did provide for the establishment of Te Taura Whiri i te Reo Māori, with its statutory role being to monitor and promote the ongoing use of the language. The commission was subsequently to play a significant role in the elaboration and standardisation of *te reo Māori*, although not always uncontroversially (see Chapter 8). While *te reo Māori* planning and policy had more direction, in reality, subsequent Māori language strategies lacked meaningful policy and practical actions that the government could take in promoting *te reo Māori* regeneration.

The great hope was that language revitalisation efforts over the past 30 years would address the significant shift from *te reo Māori* to English.

While the state of *te reo Māori* may not be as endangered as suggested by the recent Waitangi Tribunal (2010) and *Te Reo Mauriora* (2011) reports, recent studies show an ongoing decline in the percentage of Māori speakers, from 25% in 2001 to approximately 24% in 2006 (Te Puni Kōkiri, 2008). Part of the problem can be attributed to the lack of a comprehensive *te reo Māori* policy at higher levels of government.

The changes in LPP goals between the two eras of development—assimilation and (re) vernaculisation—were to influence views on *te reo Māori* corpus planning, including the various strategies adopted to add new terms to the vernacular. At the macro-level, the strategy of borrowing and transliterating words (loanwords) was abandoned by Te Taura Whiri, and coining new words became the more common strategy post-1980s. This was to eventually have a significant impact on the meso- and micro-levels of *te reo Māori* linguistic development, including the lexication of Māori-medium mathematics terms.

Drawing on literature, the following chapter examines the macro-level state education and local policies that have impacted on *te reo Māori* in schooling and thus, by extension, the development of the Māori-medium mathematics lexicon and register.

Chapter 5. *Te Reo Māori* in Education Planning

5.1 Introduction

Te reo Māori in education is situated in the third dimension of LPP, that is, language in education. However, it is important to acknowledge that the other two major dimensions of LPP—status and corpus planning—also occurred in education in Aotearoa/NZ, albeit almost exclusively in the modern era, that is, from the 1980s onward.

Schools often represent an interface between macro-level and meso- and micro-level language planning (Kaplan & Baldauf, 2003). Therefore, this chapter analyses literature that examines the historical role of education in Aotearoa/NZ in implementing overt and covert macro-level linguistic policies. This is because education was, and still is, a vital site for social and linguistic reproduction, and the inculcation of knowledge skills and attitudes, and is therefore central to the process of linguistic assimilation (Phillipson, 1992).

This chapter also draws on key literature that focuses on educational policy in the modern era affecting the development of Māori-medium schooling and *pāngarau*.

5.2 Language-in-Education LPP: The Role of Education in Assimilation

The third dimension of language planning, language in education, substantially involves the schooling sector (Kaplan & Baldauf, 1997). The educational domain was often chosen as an implementation site for national language policies, because education was most often controlled by the state and thus could be readily used as an agency of state language planning (Kaplan & Baldauf, 1997). Comprehensive critical analyses can be found in a range of research literature on the early colonisation period in Aotearoa/NZ (see Ramsay, 1972; Simon 1992) and contemporary Māori education about education policies, both overt and covert, in regard to Māori education generally (see Penetito, 2010; Smith, 1999). Consequently, this chapter analyses and draws on literature that

focuses primarily on *te reo Māori* in education to provide a context for the emergence of Māori-medium schooling in the late 1970s and early 1980s.

5.2.1 Impact of colonial linguistic hegemony on *te reo Māori* in education

At the time the first missionaries and settlers arrived, Māori had a robust system for educating their children to ensure the survival of their communities in Aotearoa/NZ (Riini & Riini, 1993). After 1840, with more and more Pākehā settlers arriving and a British colony being created, European forms of government and schooling were established. Simon (1998) argued that the hegemonic function of the missionary schools in the early 1800s was to provide a formalised context to assimilate Māori communities into European beliefs, attitudes and practices, with the intent to “civilise” the Māori population. Ironically, in the early missionary schools, the assimilatory function, primarily cultural and religious, was facilitated initially in *te reo Māori* (Smith, 1990), including the learning of literacy and numeracy. This was primarily because Māori were monolingual speakers of *te reo Māori*. Therefore, for much of the early contact between European and Māori between the 1820s and the 1870s, *te reo Māori* was the dominant language of Māori for schooling (Simon, 1998). Resources were explicitly produced in 1846 to support arithmetic taught in the medium of Māori; these included multiplication and money tables for use in missionary schools (Barton et al., 1998; Williams, 1975a). These early texts were translations carried out by government or church agents, including Māori, such as Henare Taratoa, who, along with many other diverse activities he was involved in, set up a school for teaching arithmetic and Christianity (Dixon, 2010). The arithmetic terms used in the Taratoa text were primarily “loanwords” from English and transliterated simply by giving them a Māori phonology (Trinick, 1999). These included terms like *miriona* (million), *inihi* (inch), *eka* (acre), *matipikeihana* (multiplication; Taratoa, 1858).

Two broad (and contrasting) education goals were held by European and Māori during the early colonisation period. The Pākehā-dominated colonial settler government’s aim was to civilise and inculcate Māori into European religion and culture, which required the eventual replacement of *te reo*

Māori with English as the dominant language of Aotearoa/NZ (Simon, 1992). From the Māori perspective, exposure to Western education was welcomed in the hope of obtaining European knowledge, in particular, the knowledge associated with technology that enhanced their traditional ways of life (Simon, 1992; Spolsky, 2005).

By the late 1840s, a number of policies had been introduced that implicitly supported a shift in schooling for Māori students from *te reo Māori* to English (Penetito, 2010; Simon, 1998). The first, the Education Ordinance of 1847 required missionary-funded schools to teach in the medium of English in order to receive subsidies and land grants and, at the same time, legitimated the curriculum under missionary control¹¹ (Simon, 1998).

The second significant legislative event was the introduction by the settler government of the 1867 Native Schools Act, following the Land Wars¹² of the 1860s. This Act supposedly moved the centrality of education away from the missions to secular schooling (Simon, 1992). Simon (1998) maintained that this 1867 Act was somewhat of a misnomer for Māori education because, in reality, Māori boarding schools, established later, in the 1880s (see below), remained very clearly under the control of various religions and remain so to this day (Simon, 1990). However, only a few Māori boarding schools now remain (Matthews & Jenkins, 1999; Simon, 1990). McKenzie (1982) added that, as a result of the Land Wars, there was a “desire to provide schools in villages to hasten the process of assimilation” (p. 3). The 1867 Native Schools Act provided what Ramsay (1972) described as a “dual system consisting of ‘native’ schools established primarily for Māori in rural areas and public schools for predominantly European settlers’ children” (p. 119). If Māori communities so wished, they would be provided with a school. However, there were caveats. In return, if the Māori community provided a suitable site, they would receive a school, teacher and books in the medium of English only (Simon, 1992). The 1867 Act also decreed that English should be the only

¹¹ Ironically, this practice was re-employed in the 1990s when, in order to receive state funding, *kura kaupapa Māori* were required to implement state-mandated curricula (McMurchy-Pilkington, 2004).

¹² The Land Wars, once called the Māori Wars, were a series of armed conflicts that took place in New Zealand between 1845 and 1872 (Belich, 1996).

language used in the education of Māori children, a continuation of the earlier assimilation of Māori into European culture via the education system (Simon, 1992).

In 1880, a code for native schools' operations was implemented, requiring, among other things, students to achieve mastery in English (Ramsay, 1972). Ramsey (1972) stated that this was difficult to do because the native schools were located in communities dominated by *te reo Māori* speakers. During the 1880s, Māori boarding schools were established with the express purpose of creating a Europeanised Māori elite (Simon, 1990). Once they had been through the system, these Māori students were expected to return to their tribal areas and work among their people "to help foster assimilation within the Māori communities" (Simon, 1990, p. 95).

By the turn of the century, the state education system was taking a much harder line towards the assimilation of Māori, including policy that extended the ban on the use of *te reo Māori* to include playgrounds as well as the classroom (Ka'ai-Oldman, 1988). Therefore, by the early 1900s, as a consequence of the Education Ordinance of 1847, the 1867 Native Schools Act, and the later policy banning of *te reo Māori* in school grounds, the use of *te reo Māori* had been completely excluded in many schools, and children were, in some cases, physically punished for speaking *te reo Māori* right up until the 1960s (Simon & Smith, 2001). The imposition of this hegemonic model, that is, one language (English) imposing itself on other languages (Māori), can be traced to ideologies and beliefs that influenced Eurocentric education at the time. As in other situations of colonisation, the educational policies of the time reflected strong assimilationist attitudes that linked proficiency in English to supposed best outcomes for Māori (May & Hill, 2005). McWhorther (2003) argued that, "urgencies of capitalism require governments to exact as much work and allegiance from their populations as possible, and the imposition of a single language has traditionally been seen as critical to this goal" (p. 261). Aotearoa/NZ was an emerging country during this early colonisation period and English linguistic hegemony was also utilised as a

means to build a nation state, and to gain political power and control from Māori (May, 2012).

There were a wide range of Māori views on the early Māori language education policy—from the rejectionists who hoped to maintain Māori autonomy to those who supported assimilation and the banning of *te reo Māori* in schools (Spolsky, 2005). Some Māori were comfortable with the latter approach, and there were several petitions to parliament requesting that formal (Pākehā) education be conducted in English only, even in the native schools (Simon, 1998). This behaviour is not surprising considering all Māori were still fluent L1 speakers of *te reo Māori* at that time and, consequently, the language was not seen to be under threat (Peddie, 2003). Indeed, despite the “English-only” model being a quintessential example of linguistic assimilation in schooling up until the 1960s in Aotearoa/NZ, Māori were resilient in their quest to hold fast to their language (May & Hill, 2005). *Te reo Māori* was still the dominant language of the home and community; thus, many Māori children had become bilingual, speaking *te reo Māori* at home and English at school (Benton, 1981). While many parents wanted their children to be bilingual, the possibility of *te reo Māori* becoming an endangered language was still to come.

Throughout the period following World War II and into the 1960s, the urban migration of Māori considerably changed the demographics of the country (May & Hill, 2005). This urban shift by Māori families led to a new generation of young Māori being brought up far from their local marae—the hub of a Māori-speaking community (Smith, 1996). Young Māori were losing their language and culture as a consequence (King, 2007). By the mid-1950s, a crisis in race relations was also being precipitated by the challenges created by Māori urbanisation and the considerable Māori student underachievement compared with Pākehā students (Smith, 1996). The crisis was defined by dominant Pākehā interests as the “Māori problem” (Smith, 1996, p. 348). In response, the government commissioned the 1960 Hunn Report to codify New Zealand race relations. The report promoted a shift in ideology in education from one of

assimilation to one of integration for Māori, in which the school was the nursery of integration (Smith, 1996, p. 349).

Irwin (1989) described integration as a less crude, less racist version of assimilation. However, the ideology of cultural superiority persisted and became “disguised in the covert aspects of integration” (Irwin, 1989, p. 4). May (2008) further argued, “integration proved not so different in either theory or practice from its predecessor—assimilation” (p. 27). For example, the Hunn Report (Hunn, 1960) described the Māori language as a “relic of ancient Māori life” and Māori student underachievement, in the main, was put down to parental apathy, indifference and Māori people “debarring themselves of their own volition” (pp. 22–25). The solution at this juncture was in remedying the so-called “deficient cultural background of Māori children” and to conform to the Pākehā way of life (Bishop & Glynn, 1999, p. 38).

By the 1960s, some formal resistance began to emerge to English-language hegemony in education from Māori, albeit in a limited form. Māori language and culture were formally reintroduced into the schools in 1962 when a formal review of the education system,¹³ the Currie Commission, included in its recommendations the teaching of *te reo Māori* as an optional subject at secondary level (May, 2001). Some *te reo Māori* was taught in a few primary schools, and in 1960, the Department of Education began publishing a Māori language journal for use in those schools where Māori was taught (Hohepa, 1999). While *te reo Māori* had been offered as a secondary school subject back in 1923 in a very limited number of schools, the 1960s and 1970s saw an increase, albeit very small, in the number of schools offering it as an optional subject (Hohepa, 1999). The release of the Currie Report¹⁴ in 1962 also ignited fierce debate over literacy and numeracy standards in New Zealand state primary and secondary schools, and again raised concerns about the poor level of Māori student achievement (Openshaw & Walshaw, 2010). However, Penetito (2010) argued that these reports (i.e., Currie, 1962;

¹³ See Penetito (2010) for a review of Māori education reports published between 1960 and 2000.

¹⁴ Currie Report: Report to the Commission on Education in New Zealand—see Penetito (2010) for a review.

Hunn, 1960) ensured “Māori education remaining a peripheral activity in education” rather than “penetrating the dominant system in some fashion” (p. 138). Despite the dominating influence of assimilation and then integration—the gap between Māori and non-Māori educational, social and economic wellbeing had not only persisted but also actually increased (Chapple, Jefferies, & Walker, 1997).

The effects of these education policies on language between Māori and New Zealand citizens are clearly evident. May (2005) highlighted that, by the 1960s, Aotearoa/NZ was one of the most linguistically homogeneous countries in the world. The negative factors affecting the status of *te reo Māori* pre-1980s significantly outweighed the positives.

5.3 The Development of *te Reo Māori* in Education: Modern Era

The change in the status of *te reo Māori*, from an initially high-status language of early colonial communication to a low-status language in Aotearoa/NZ, had contributed considerably to language shift to English in the Māori community, to the extent that *te reo Māori* was considered an endangered language (Spolsky, 2005). It was against this background of rapid and significant language loss that the Māori community initiated bilingual education in Aotearoa/NZ (May & Hill, 2005). The following sections examine the development of the various school initiatives that occurred in response to the parlous state of the language: first, bilingual and then Māori-medium education.

5.3.1 Bilingual education developments 1970s–1990s

At the point of the reintroduction ((re) vernacularisation) of *te reo Māori* in the form of bilingual education in the late 1970s and early 1980s, there was no national language plan and no formal language policy for *te reo Māori* use and implementation in Aotearoa/NZ (Peddie, 2003). In 1976, in response to the increasingly parlous state of the language, the rural Ruatoki community located in the Tūhoe tribal area in the North Island were able, through the strength of their own convictions and the use of data from the seminal Benton (1981) study into the health of *te reo Māori*, to persuade both the Minister of Education and officials of the Education Department (changed to Ministry of Education in 1991) that a bilingual

school should be set up in Ruatoki (Benton, 1984). Subsequently, in 1980, additional schools, including the former Māori (native) schools in predominately rural areas, such as Tawera, Hiruharama and Omahu, were also given official bilingual status. These schools, with support from their elders and local *whānau*, were trying to save *te reo Māori* from extinction in their particular communities (Benton, 1984). By 1988, 12 years after this change of status for schools such as Ruatoki, 20 bilingual schools had been established in predominantly Māori communities, including in urban areas. In addition, 67 primary schools and 18 secondary schools operated with some bilingual classes (May, 2001).

These early bilingual schools were required to follow the English-medium Syllabus for Schools—Mathematics: Junior Classes to Standard Four (Department of Education, 1985) and Mathematics: Forms 1 to 4 (Department of Education, 1987). There was no formal Māori-medium curriculum, and limited *te reo Māori* resource materials to support learning and teaching. Their development reflected a wider trend at that time—much of the school curriculum, resource development and long- and short-term Māori language-in-education planning was highly localised, responsibility having fallen to principals, staff and *whānau* communities of individual schools (Benton, 1984). Consequently, the implementation of a bilingual-school-based curriculum varied widely from community to community (Benton, 1984). From my observations and anecdotal evidence, mathematics was still taught in the medium of English in most of these bilingual schools, with the odd Māori-language mathematics term used occasionally. Meanwhile, New Zealand mathematics programmes were directed loosely by syllabi and guidelines modelled on the “new maths” reform movement in mathematics education imported from the United States in the 1960s (see Herrera & Owens, 2001, and Shearer, 2002, for discussion on the new maths reforms in the late 1970s).

Following on from these early bilingual education reforms, *kōhanga reo* (early childhood language nests) were launched in 1982, initially run independently by parents as an important part of the “Māori renaissance”, motivated by widespread Māori recognition of the urgent need to revitalise *te reo Māori* by that time (King, 2001). The term “Māori renaissance” refers

to the revival in fortunes of the Māori of Aotearoa/NZ, beginning in the latter half of the 20th century (Webster, 1998). As many commentators on this renaissance have noted, *kōhanga reo* were probably the most influential development in the language revitalisation movement in Aotearoa/NZ (King, 2001; Penetito, 2010; Walker, 1990, 1996). *Kōhanga reo* are based on the concept of intergenerational language transmission, whereby the native speakers of the “grandparent” generation foster cultural and language acquisition by children, thereby overcoming the post-1940s generation’s rupture or severance from *te reo Māori* (Campbell & Stewart, 2009). The *kōhanga reo* movement, as a *whānau*-driven, grassroots initiative, was also seen as a means of developing cultural and political autonomy/emancipation from the state education system (Smith, 1990; Walker, 1990). This is linked to the sociological argument that control of the education system represents control of society (Freire, 1970, 1972; Illich, 1972).

Outside the few bilingual schools noted previously, however, most of the compulsory state education sector remained ambivalent towards or actively resisted Māori community language aspirations (McMurchy-Pilkington & Trinick, 2008). Linguistic human rights had not yet emerged as an influential paradigm in resisting language shift and language death, and the Māori Language Act was not yet a reality (May, 2003). Graduates from *kōhanga reo* were entering the state school primary-level system into questionable or, in most cases, non-existent *te reo Māori* programmes and, as a consequence, concerns emerged about their language loss after a short period of time in these schools (Smith, 1997). The poor response by state schools to these initial *te reo Māori* revitalisation efforts prompted groups of Māori to establish primary-level *kura kaupapa Māori* from 1985, outside the state education system (Smith, 1997).

5.4 (Re) vernacularisation of *te Reo Māori*: The Education Amendment Act 1989

Somewhat belatedly, and after considerable lobbying from *te reo Māori* education groups, the Education Amendment Act was passed in 1989, and it was to have far-reaching implications, albeit of different time scales, for *te reo Māori* in schooling. One of the “short-lived” implications was that

the Education Amendment Act required “all schools” to ensure all reasonable steps were taken to provide instruction in *tikanga Māori* (Māori cultural practices), and in the Māori language where demand for this existed (de Bres, 2008). Even though there were questions raised about the quality of *te reo Māori* practised by the bilingual schools established in the late 1970s and early 1980s (McMurchy-Pilkington, 2004), an unexpected consequence of this Education Act was that Māori groups demanded mainstream schools (including secondary) make available Māori immersion or bilingual units in their schools, regardless of the number of Māori students (McMurchy-Pilkington & Trinick, 2008). Because it was a legislative requirement that all state-funded schools implement the policy, the customary excuses, such as low student numbers or lack of staff capability, could not be used as a pretext for inaction and or ambivalence. As a result, there was an unexpected proliferation of bilingual units in English-medium secondary schools, in particular, attempting to teach mathematics and science in the medium of Māori (Ohia et al., 1989, 1990). However, the growth in bilingual education in state mainstream schools was subsequently to come to an abrupt halt.

Unfortunately for *te reo Māori* revitalisation efforts, the government—in response to right wing agitation from communities and schools—quickly changed components of the 1989 Education Act in a 1990 Education Amendment Act to delete any legal obligation on the part of mainstream schools to respond to parental and community requests for *te reo Māori* programmes (McMurchy-Pilkington & Trinick, 2008). Māori linguistic rights were marginalised once again and revitalisation efforts in mainstream state schools, particularly state secondary schools, were significantly diluted (McMurchy-Pilkington & Trinick, 2008).

The Education Act 1989 did, nonetheless, crucially endorse Māori-medium schools, *kura kaupapa Māori*, at primary (and secondary) level as a legitimate state-funded schooling alternative within the state education system (May, 1999), serving those students who had been in *kōhanga*. While state support of *kura kaupapa Māori* has since proved something of a double-edged sword, requiring *kura* to implement state-mandated curricula and assessment practices developed from essentially

Eurocentric interests, the 1989 Education Act at least provided the opportunity for *kura kaupapa* to gain financial and operational support in the further expansion of Māori-medium education (McMurchy-Pilkington & Trinick, 2008).

The demand from Māori for secondary Māori-medium education did not cease with the 1989 Education Act and the 1990 Education Amendment Act, *kōhanga reo* and *kura kaupapa Māori*. As noted by May and Hill (2005), there was a domino effect throughout the education system. There was increasing demand for Māori-medium secondary schooling options, in order to meet the educational needs of fluent Māori-speaking students graduating, in turn, from *kura kaupapa Māori* (May & Hill, 2005). The first state-funded *wharekura* opened in 1993 with Year 9 and 10 students at Hoani Waititi Marae, in West Auckland (Campbell & Stewart, 2009). *Wharekura* are the secondary school prototype of Māori-medium immersion, as distinct from *kura kaupapa Māori*, which focus on the primary level. Since that time, a number of *wharekura* have emerged, generally attached to *kura*, with common governance and management (Ministry of Education, 2008a).

A few of the more resilient bilingual and/or immersion units within mainstream schools continued to develop during the 1990s, despite the lack of support from the state. The teaching of curriculum areas, such as mathematics (*pāngarau*), began to come to the fore (Ohia et al., 1989, 1990). Most of the key individuals involved in the subsequent *pāngarau* lexical and curriculum development were teachers in these secondary-level contexts during this period. Indeed, this group of Māori-medium mathematics educators (Te Ohu Pāngarau—see Chapter 7) were to play a pivotal role in the subsequent development of the Māori-medium numeracy strategy, including curriculum and dictionary development.

5.4.1 Contested definition of Māori-medium education

For expediency, in Aotearoa/NZ educational discourse (including this thesis), *kura kaupapa Māori*, *kura-ā-iwi*, and immersion units in English-medium schools are frequently lumped together as Māori-medium education. However, philosophically, structurally and historically, bilingual

schools, *kōhanga reo* and *kura kaupapa* are very different (May & Hill, 2005). Bilingual schools were formerly English-medium schools but, with considerable groundswell support from their local communities in the late 1970s and early 1980s, pressured the state into reclassifying their local school as a bilingual school (Benton, 1984; see above). Currently, the bilingual label for classifying *schools* as opposed to *units*, is no longer used.

Kura kaupapa Māori, a grassroots initiative, were developed from outside the state system, not only to revitalise *te reo Māori*, but also as a resistance movement to the assimilationist aspects of New Zealand European schooling (Penetito, 2010; Smith, 1999). These *kura* adhere to *Te Aho Matua* as their curriculum policy (see Section 6.5).

Ironically, *Te Aho Matua* policy requirements underpinning *kura kaupapa Māori* were considered too restrictive and disempowering for some Māori communities (May, Hill, & Tiakiwai, 2006). They wanted to exercise their own local authority rather than be part of and controlled by the *kura kaupapa Māori* collective. Consequently, the government agreed to the establishment of “special character” schools called *kura-ā-iwi* (tribal schools), also delivering Māori-medium education (May et al., 2006). The philosophy of *kura-ā-iwi* is based on the practices, language and history of a specific *whānau*, *hapū* (subtribe) or *iwi* (tribe). Essentially, the special character of the school is to teach in the medium of Māori using the local tribal dialect, to teach the tribal knowledge of the area and to provide an educational environment that promotes, among other things, management and self-determination of the *tangata whenua* (people of the land) of that tribal area (May et al., 2006).

The third category of Māori-medium schooling is the bilingual/immersion units in English-medium schools, a concept established in the 1980s and 1990s (May & Hill, 2005). Some bilingual units have since evolved to become full immersion units. These immersion units are necessarily delimited in terms of their power and authority, given that they remain within mainstream (English-medium) schools’ control, in contrast to the separate, whole-school and thus more autonomous *kura kaupapa Māori*

and *kura-ā-iwi* (McMurchy-Pilkington, 2004). However, this should not devalue their role in supporting *te reo Māori* revitalisation (May & Hill, 2005).

Nonetheless, *kura kaupapa Māori*, based on the philosophies underpinned by *Te Aho Matua*, argue that being lumped together with “immersion and bilingual units” under the label “Māori-medium” is marginalising for them. In this country, Māori language education institutions are frequently judged by the level of autonomy the entity has and who holds the reins of power (McMurchy-Pilkington, 2004). One of the main ideas expressed by *Te Aho Matua*, for example, is the notion of self-determination with the objective of interrupting assimilationist education practices (Smith, 1997). In contrast, immersion units in English-medium schools are still, in general, governed by English-medium/mainstream concerns, goals, practices and authority (Hohepa, 2010).

In Aotearoa/NZ, “bilingual education” is not regarded as immersion education, even though Māori-medium schooling has emerged from bilingual schooling and the desired outcome is to produce students who are bilingual. This is contrary to the situation in other countries, where immersion education is regarded as one form of bilingual education (May & Hill, 2004, 2005), and located on a continuum (Hornberger, 2002). Unfortunately, in the context of Aotearoa/NZ schools, bilingual education has become equated with lower levels of immersion (May & Hill, 2005) and tokenistic attempts to revitalise the Māori language (McMurchy-Pilkington, 2004). One of the responses to the lower levels of immersion being achieved in state schools, was the development of a *te reo Māori*-only ideology in *kura kaupapa Māori*, where *te reo Māori* is of such integral and foundational importance that the use of two languages, as is suggested by the term “bilingual”, is antithetical to those dedicated to *te reo Māori* revitalisation (Hornberger, 2002).

5.5 Kura Kaupapa Māori: Te Aho Matua Policy

When *kura kaupapa Māori* were officially recognised by the state in 1990, the pioneers of the *kura kaupapa* movement at that time developed a language planning policy known as *Te Aho Matua o ngā kura kaupapa*

Māori (abbreviated to *Te Aho Matua*) to provide a philosophical base distinct from mainstream/English-medium education (Nepe, 1991). *Te Aho Matua* lays down the principles by which *kura kaupapa Māori* identify themselves and provides a language planning policy for parents, teachers and boards of trustees (Nepe, 1991). In 1999, these principles were introduced into legislation in the form of the Education (*Te Aho Matua*) Amendment Act 1999 (Meaney et al., 2012). *Te Aho Matua* principles include:

1. **Te Ira Tangata** (the human essence), affirms the nature of the child as a human being with spiritual, physical and emotional requirements
2. **Te Reo** (the language), deals with language policy and how the schools can best advance the language learning of their children
3. **Ngā Iwi** (the people), focuses on the social agencies which influence the development of children, in short, all those people with whom they interact as they make sense of their world and find their rightful place within it
4. **Te Ao** (the world), deals with the world which surrounds children and about which there are fundamental truths which affect their lives
5. **Āhuatanga Ako** (circumstances of learning), provides for every aspect of good learning which the *whānau* feel is important for their children, as well as the requirements of the national curriculum
6. **Ngā Tino Uaratanga** (essential values), focuses on what the outcome might be for children who graduate from *kura kaupapa Māori* and defines the characteristics which *kura kaupapa Māori* aim to develop in their children. (Department of Internal Affairs, 2008, p. 740)

The *Aho Matua* policy sets out an approach to teaching and learning requiring, among other things, “that all subjects [are] to be taught only in the medium of Māori, and that there is a clear separation and division between time, place and speakers of English and Māori languages, and discourages such practices as mixing or ‘code switching’ of the two languages” (Department of Internal Affairs, 2008, p. 736). However, research shows that for many children in *kura kaupapa Māori*, English is their L1 (May & Hill, 2004; Rau, 2004), and there may be some advantage for students to learn in English from time to time.

There are researchers who maintain that clear, sustained separation of languages in immersion instruction advocated by policy such as *Te Aho*

Matua is a valid pedagogical approach (Cloud, Genesee, & Hamayan, 2000; Tarone & Swain, 1995; Swain, 1983). One of the most compelling reasons for separating the languages of instruction is the concern that encouraging the use of both languages will favour the more proficient language, typically, the home language or L1. This is especially so in the Aotearoa/NZ context when the home language is most often English, the language of the majority and the language of power in the larger society (Tarone & Swain, 1995).

However, other scholars challenge the practice of language separation according to time and place, arguing that there is a place for “judicious” use of the L1 to support L2 learning in bilingual programmes, such as the model advocated in *Te Aho Matua* (Cummins, 2007, 2008; McMillan & Turnbull, 2009, Swain & Lapkin, 2000). Cummins (2007) questioned the “rigid” separation of languages in bilingual programmes and argued that research evidence provides minimal support for these assumptions. Additionally, researchers argue strongly that bilingualism and biliteracy cannot be achieved through monolingual philosophy or methodology, and that using the students’ total language resources is more effective (Baker, 2006; Cummins, 2007, 2008).

It must be noted that *Te Aho Matua* policy does not exclude the teaching of English and promotes, as one of its core principles, full competency in “Māori and English” for the children of their *kura* (Department of Internal Affairs, 2008, p. 742). It is also important to acknowledge that, at the political level, the support that mathematics in the medium of Māori has received, including lexical development, can be attributed in part to the strict *te reo Māori*-only policy of *Te Aho Matua*. Historically, *te reo Māori* revitalisation has frequently not been at the forefront of government policy decisions and its agencies. For example, in the absence of a specific *te reo Māori* plan for education, the Ministry of Education quickly defaults to the needs of English-medium education as the “norm” (McMurchy-Pilkington & Trinick, 2008). Agencies such as the Ministry of Education need constant political pressure to support initiatives and resources that directly foster the continued development of Māori-medium education. The principles of *Te Aho Matua*, indirectly and directly, provide a persistent

reminder to educational agencies to pay heed to Māori-medium education needs, partly because of the policies' status in New Zealand law.

5.6 Māori-Medium Education: 1990s Neo-Liberal Policies

At the time *te reo Māori* revitalisation schooling efforts were gaining momentum in the 1980s, a neo-liberal transformation began in Aotearoa/NZ with a raft of reforms, centred particularly on how state institutions including education were to be (re) structured and managed (Olssen & Mathews, 1997). These reforms were underpinned by a shift in ideology to a more market-oriented perspective, whereby Aotearoa/NZ became a fully participating member of the rapidly globalising economy (Olssen & Mathews, 1997). This resulted in major education policy reforms, including considerable curriculum reform in areas such as mathematics (McMurchy-Pilkington & Trinick, 2002, 2008). The following sections investigate the impact of these policies on education generally and, by default, on Māori-medium education, and thus development of *pāngarau*.

The major restructuring of education began in 1987, and a taskforce was commissioned in 1988 to carry out an inquiry into education, resulting in the publication in May 1988 of a report called *Administering for Excellence*, commonly referred to in Aotearoa/NZ educational discourse as the Picot Report—so named after the chair of the taskforce group Brian Picot (McMurchy-Pilkington & Trinick, 2008). This taskforce recommended a radical restructuring of the New Zealand system of education along neo-liberal, market-oriented lines (Olssen & Mathews, 1997). The Picot Report proclaimed “choice” as the first of its core values, and stated that this “will involve providing a wider range of options both for consumers and for learning institutions” (Picot, 1988, p. 4).

The central tenet of the “public choice” ideology underpinning the Picot Report is that human behaviour is dominated by self-interest (Boston, Martin, & Walsh, 1996); therefore, if schools do not meet Māori educational demands, Māori will “opt out” and choose to go elsewhere (Meaney et al., 2012). Māori language education becomes contestable in an open market, with schools and services competing for provision of

services. New Right economic theory advocates the operation of a free market so that individuals are free to make their own choices. Stokes (2003) and Penetito (2010) suggested that it was this ideology that gave support to the government's decision to integrate *kura kaupapa Māori* into the state-funded education system via the 1989 Education Act. While this decision was posited in a neo-liberal framework, at times undermining of other aspects of education, it did provide the window or space for funding (see Smith, 1999, for a critique of the impact of neo-liberal economic restructuring on Māori). This exemplifies Kaplan and Baldauf's (2003) argument that market forces sometimes drive language-in-education policies. Prior to 1989, *kura kaupapa Māori* operated as private schools, reliant on financial support from *whānau*. The 1989 Education Act provided the opportunity for *kura kaupapa* to gain financial and operational assistance. However, *kura kaupapa Māori* became accountable to state legislature and regulatory compliance (Stokes, 2003), including the implementation of state curricula.

5.7 Curriculum Reforms Aotearoa/NZ 1990s: A New Paradigm in Education

Before the 1990s, mathematics teaching in New Zealand schools was guided by descriptive syllabi. This was to change significantly in the 1990s with the development of prescriptive curricula as a consequence of the new paradigms influencing educational policy (McMurchy-Pilkington & Trinick, 2002). Controversially, various governments in Aotearoa/NZ determined not only how education was to be administered (e.g., The Picot Report), but also how curriculum was to be developed (e.g., The Porter Project; O'Neil, 2004). With respect to the latter, the then Minister of Education seized upon the Crocombe, Enright and Porter (1991) report (The Porter Project) as a rationale for viewing curriculum and assessment reform as a tool for lifting New Zealand's competitive advantage vis-à-vis the global economy (Codd, 1997). Initially in the curriculum reform process, no consideration was given to the needs of schools teaching in the medium of Māori (McMurchy-Pilkington & Trinick, 2002). This caused considerable consternation in the Māori-medium schooling community, which, up to this point, had been required to follow the mainstream

English-medium syllabi (McMurchy-Pilkington & Trinick, 2002, 2008). Although the 1990s administrative and curriculum reforms were based on New Right/neo-liberal ideologies, with some expectation around public choice, the outcome followed customary Eurocentric patterns of marginalising Māori interests (McMurchy-Pilkington & Trinick, 2008). The key policy reform document, *The New Zealand Curriculum Framework* (Ministry of Education, 1993), for example, makes no mention of a Māori language curriculum or equivalent Māori-medium curricula for the essential learning areas. The framework was followed by curriculum policy documents (with the exception of mathematics that had already been developed) only in the medium of English in all the major subject areas (see Ministry of Education, 1991, 1993).

The subsequent agreement by the Minister of Education in the early 1990s to develop a specific Māori-medium mathematics curriculum—*Pāngarau i roto i te Marautanga o Aotearoa* (see Te Tāhuhu o te Mātauranga, eventually published in 1996)—thus came as somewhat of a surprise, albeit an agreeable one (McMurchy-Pilkington et al., 2013). While on one level the Minister's acquiescence was surprising, the development of a numerate society has been the goal of the Aotearoa/NZ education system for some time (McMurchy-Pilkington et al., 2013).

5.7.1 Curriculum development: *De facto* language planning

This study suggests that, in the absence of any official Māori-medium education plan, the development of Māori-medium curricula such as the *Pāngarau i roto i te Marautanga o Aotearoa* (Te Tāhuhu o te Mātauranga, 1996, 2008) became *de facto* language planning. Traditionally in language planning research, this sort of policy work was not considered language planning per se. More recently, Hornberger and Johnson (2007) introduced the ethnography of language policy as a method for examining the agents, contexts and multiple layers of language planning. They argue that ethnographies of language policy can illuminate and inform various types of language planning, including the official and unofficial, *de jure* and *de facto* (Hornberger & Johnson, 2007).

The following section examines the development of two iterations of the *pāngarau* (Māori-medium mathematics) curriculum for classroom teaching in *te reo Māori*, one in the period 1993–1996 and the other in the period 2006–2008 as components of the broader curricula developments. First, however, it is useful to provide a timeline and diagrammatic explanation of the various curricula because it can be quite confusing without familiarity of *te reo Māori* curricula developments. The following timeline is drawn from McMurchy-Pilkington et al. (2013).

Phase 1: 1991–1996

- 1991. *Mathematics in the New Zealand Curriculum* (Ministry of Education, 1991).
- 1993. *The New Zealand Curriculum Framework* (Ministry of Education, 1993) was an overarching statement on curriculum. Ironically published after the mathematics curriculum.
- 1993. *Te Anga Marautanga o Aotearoa* (Te Tāhuhu o te Mātauranga, 1993). Translated directly by Taura Whiri from its 1993 English-language version above.
- 1996. *Pāngarau i roto i Te Marautanga o Aotearoa* (Te Tāhuhu o te Mātauranga, 1996). This is the Māori-medium version of the English-medium version above; see discussion below.

Phase 2: 2006–2008

- 2006. *New Zealand Curriculum* (NZC; Ministry of Education, 2006). Revised version of the NZ curriculum framework.
- 2006. *Mathematics in the New Zealand Curriculum*—becomes a section in NZC.
- 2008. *Te Marautanga o Aotearoa* (MoA; Te Tāhuhu o te Mātauranga, 2008). No longer a translation of NZC.
- 2008. *Pāngarau i roto i te Marautanga o Aotearoa*—becomes a section in MoA. No longer a direct translation of *Mathematics in the NZC*.

Phase 1: 1993–1996

As an outcome of the Aotearoa/NZ curriculum developments in the period 1991–1996, a new mathematics curriculum eventually emerged in the medium of Māori (see Te Tāhuhu o te Mātauranga, 1996). This was the first time in the long history of schooling and curriculum development in Aotearoa/NZ that Māori educationalists were given some authority,

however limited, to develop state curricula (McMurchy-Pilkington et al., 2013). However, for those involved in the development of the curriculum statement for mathematics (*pāngarau*), their initial excitement was tempered by the Ministry of Education's contractual requirement that the structure had to "mirror" the hegemonic English-medium version (McMurchy-Pilkington & Trinick, 2002). The Māori-medium version of the curriculum had to have the same achievement objectives and mathematical strands, and had to be based on eight levels of progression, as in the English-medium version (McMurchy-Pilkington & Trinick, 2002).

Despite these restrictions, the writers saw the process as an opportunity to advance linguistic developments, and after some 12 months of writing and consulting with the Māori-medium sector, a *pāngarau* curriculum was produced (McMurchy-Pilkington & Trinick, 2002). Much to the dismay of the writers contracted by the Ministry of Education to develop a Māori-medium document, their version was discarded and Te Taura Whiri (Māori language Commission) was subsequently commissioned to translate the English-language version of the learning outcomes into Māori (McMurchy-Pilkington & Trinick, 2002). The rationale given by the Ministry of Education at the time was that, while the structure appeared to reflect the English-medium version—for example, similar mathematics strands and levels—the learning outcomes (content) did not mirror the English-medium version (McMurchy-Pilkington & Trinick, 2002).

The Māori-medium writers had not attempted to provide a word-for-word translation; that was neither a contractual requirement nor a prudent way to develop curricula (McMurchy-Pilkington et al., 2013). It raises the question as to why the Māori writers (including myself) continued to support this particular curriculum development and its eventual implementation.

When both English-medium (see Ministry of Education, 1991) and Māori-medium curricula (see Te Tāhuhu o te Mātauranga, 1996) were developed, the Ministry of Education, as the agent of the government and, in particular, the Minister, had specific conceptions about how the curriculum development process would be undertaken and what the

finished curricula would look like (McMurchy-Pilkington et al., 2013). On the one hand, these were based on their understandings of how to make schools accountable to the government and in relation to the neo-liberal notion of the building of human capital (O'Neill, 2004). On the other hand, Māori language and cultural revivalists, such as the Māori-medium mathematics curriculum developers, saw an opportunity to co-opt the development of a Māori-medium mathematics curriculum to serve their community of interests' linguistic needs, including the development of a Māori-medium mathematics register (McMurchy-Pilkington et al., 2013).

As McMurchy-Pilkington (2004) noted, for the Māori-medium curriculum developers, the primary goal at the time was not necessarily a *pāngarau* curriculum in itself, but the opportunities the development of a state-mandated curriculum would provide for Māori-medium education more consistently than it had hitherto. To support the development of the *pāngarau* curriculum, the state funded a series of consultation meetings with various key stakeholder groups, including *kaumātua* (elders), to extend and to consider the appropriateness of the *pāngarau* corpus of terms that had been developed thus far (see Chapter 7 for further discussion). These consultation meetings resulted in a more robust discussion with the community and in some terms being accepted and others rejected (Barton, 1990; McMurchy-Pilkington et al., 2013). For example, initially an even number was variously termed a *tau tika* (correct number), *tau kehe kore* (not an odd number) and *taurite* (similar number; Barton, 1990, p. 7). During the development of the *pāngarau* curriculum, these terms were all rejected and *taurua* (multiple of two) became the norm (see Te Tāhuhu o te Mātauranga, 1996). This more inclusive process also probably encouraged later acceptance of the standardised corpus of terms by most of the Māori-medium education community (McMurchy-Pilkington et al., 2013).

With implementation of the *pāngarau* curriculum now a requirement under legislation, the Ministry of Education was obliged to support teachers and schools through a range of initiatives, including professional development and the publication of resources to support teaching and learning (McMurchy-Pilkington et al., 2013). While this support was inadequate to

address all the challenges of teaching mathematics in *te reo Māori*, an outcome of these initiatives was that terminology and register development accelerated and became more systematic and planned. This enabled the teaching of *pāngarau* to higher levels of schooling, thus providing another opportunity to elaborate the language. Trinick (in McMurchy-Pilkington & Trinick, 2002) stated that the writing of the curriculum “legitimised the teaching of mathematics in Māori . . . led to teacher, advisor and resource teacher of Māori professional development . . . that suited their specific needs [and] many Māori were involved in mathematics education debate” (p. 36). The determination by Māori to revitalise their language saw them take advantage of the spaces that had opened up in the development process, making the process a more enabling one, even within the heavy contractual constraints placed on them by the state (McMurchy-Pilkington & Trinick, 2008).

Phase 2: Revision of *pāngarau* curriculum 2006–2008

In Phase 1 of the Māori-medium curriculum developments, 1993–1996, it was agreed by Cabinet that the publication of curriculum statements would be followed by a curricular stocktake to reflect on a decade of developments and their implications for teaching and learning, and to consider future curricula directions (O’Neil, 2004). While the basic structure of the 1996 *pāngarau* curriculum was to be maintained, the earlier restrictive requirements, for example, that it had to be a translation of the English version, were removed in the 2006–2008 revision (McMurchy-Pilkington et al., 2013). There had been a number of political and educational changes over the previous 13 years that facilitated this change. While the basic tenet of neo-liberal ideology lived on and underpinned the revision of the curricula in 2006–2008, the capacity to develop Māori-medium curriculum had expanded significantly over the intervening decade and the “Ministry of Education appeared more accommodating of difference” (McMurchy-Pilkington et al., 2013, p. 357).

5.7.2 Government’s numeracy strategy 1999–2009

The impetus (and state support) to develop Māori-medium curricula can also be linked to the status of numeracy in the school curriculum in

Aotearoa/NZ. The development of a numerate society has always been a goal of the Aotearoa/NZ education system, particularly so in the latter stages of the 20th century, when the nation's education system and curricula were reformed to respond to the challenge of an economic climate of competitive and complex overseas markets, including the need to work towards a knowledge society (Apple, 2004; Ministry of Education, 2001). Within this context of social and political change, and linked to the "marketisation" of the Aotearoa/NZ education system, is the role of "numeracy and literacy" in preparing the workforce for a competitive world economy. This is because, as Apple (2004) observed, neo-liberals tend to link academic achievement in these areas to international competitiveness (or lack thereof). These sorts of ideologies have led to initiatives, such as state standards or standard mathematics curricula, used in public schools in Aotearoa/NZ, the United States and Great Britain¹⁵ (Tienken, 2011).

Results of the 1994/95 Third International Mathematics and Science Study (TIMSS) found that Aotearoa/NZ students' achievements in mathematics were below international averages (Garden, 1997). The government responded by establishing the Mathematics and Science Taskforce (1997). The findings and recommendations of the taskforce subsequently provided direction and alignment for a range of policies, projects and programmes aimed at improving achievement in numeracy by learners in the Aotearoa/NZ education system. The Mathematics and Science Taskforce identified that primary teachers were not confident in mathematics teaching, which was attributed to their lack of understanding of the content knowledge of mathematics, and minimal understanding of associated effective pedagogy (Ministry of Education, 1997). Professional development for all mathematics teachers was recommended to address this issue, along with the publication of support material for children and teachers (Ministry of Education, 1997). Consequently, an increased focus on numerical literacy was brought to the fore as part of a comprehensive strategic numeracy policy for Aotearoa/NZ to raise achievement

¹⁵ There is, however, evidence that a ranking on an international test of academic skills and knowledge does not have the power to predict future economic competitiveness, and is otherwise meaningless for a host of reasons (Baker, 2007; Bracey, 2009; Tienken, 2008, 2011).

standards; this culminated in the Numeracy Project (Ministry of Education, 2001). Mathematics education research conducted between 2001 and 2010 suggests the outcomes of the numeracy projects have been generally positive (Young-Loveridge, 2010).

Māori-medium schools did not participate in the TIMMS study (the study was available in the medium of English only). In early discussions with the Ministry of Education it became quite clear that minimal consideration had been given to the implications of the numeracy project for teachers in Māori-medium education (McMurchy-Pilkington et al., 2013). However, specialists had been lobbying for a professional learning programme for some years and could see that, with adaptations, a similar project designed for Māori-medium would be very beneficial (McMurchy-Pilkington & Trinick, 2008). The outcome was the development of a parallel (not merely a translation) Māori-medium numeracy project, eventually called Poutama Tau, between 2002 and 2010 (Trinick & Stephenson, 2010). The primary focus of the Poutama Tau Project was to raise teacher competency in the discipline, raise student achievement and support the revitalisation of *te reo Māori* (Christensen, 2003; Trinick & Stephenson, 2010). This is consistent with Durie's (2001) argument, with regard to Māori, that being numerate can support access and participation in society and the economy. While this is an instrumental function of language, being numerate through the Māori language has the potential to strengthen and develop Māori society and knowledge.

5.8 Summary

Paradoxically, schooling in Aotearoa/NZ has played a pivotal role in supporting *te reo Māori* loss or, in the modern era, its reclamation. One of the major ideologies behind the initial language planning processes by the early colonial government for education had been linguistic assimilation through government agencies such as schools. Linguistic assimilation, often based on covert language goals, came to the fore as power relations between Māori and Pākehā changed in the 1800s. The notion of power and control can be illustrated with the passing of the 1867 Native Schools Act, which decreed that English would be the only language used in the education of Māori children.

The main goal of assimilation was supported by successive governments and their agencies, which implemented a range of educational policies, both overt and covert, to privilege English as the sole language of education. Although legislation such as the 1847 Education Ordinance and the 1867 Native Schools Act were common practice at that time, today these activities and policies are seen by many as the violation of the linguistic rights of indigenous people, including under the United Nations policy known as the *Universal Declaration of Linguistic Rights* (May, 2003). The various educational policies took nearly a century to take full effect as Māori shifted from being monolingual speakers of *te reo Māori* to bilingual speakers and eventually monolingual speakers of English by the 1970s.

In contrast to the first era, Māori were able to exact some compromises after the 1970s by leveraging their limited political power at the national level and by initiating new educational initiatives at various levels of education (Penetito, 2010). This chapter traced the various schooling initiatives and institutions developed in response to the perilous state of *te reo Māori* in the 1970s. Some schooling initiatives were created outside the state education system in the 1980s, for example, *kōhanga reo* and *kura kaupapa Māori*, and some were developed from within, such as bilingual schools and immersion units. In the absence of a coherent LPP for Māori-medium schooling at the meso-level, Māori-medium schooling and *pāngarau* education development, including the modernising of the lexicon and elaboration of the language, have been directly managed by political imperatives underpinning English-medium schooling and mathematics education, rather than an implicit LPP for Māori-medium education. Government initiatives such as the numeracy strategy curriculum development have acted as *de facto* language plans and have often come about only as a reaction to lobbying from Māori interest groups. As a minority group, Māori interests are often marginalised and reinterpreted to conform to preconceived notions centred on what is good for English-medium education.

There have been positive outcomes for Māori-medium education. The existence of a single Māori-medium curriculum document for Years 1–13

(*Te Marautanga o Aotearoa*) has meant a new and enduring dialogue between primary and secondary schools and teachers in professional settings. The corollary of state requirements under government legislation in Aotearoa/NZ was that state educational agencies were obliged to support teachers and schools to implement legislative requirements, such as curricula. To develop the curriculum required a considerable amount of corpus development, resource development, curriculum and teacher professional learning and development. Nearly every initiative of this kind turned up new *te reo Māori* needs and suggested new words, or a revised term for existing words. Thus, increased classroom use and increased sophistication of language used in the teaching and learning of *pāngarau* has kept expanding the corpus of mathematics terms.

While the Ministry of Education's support has been insufficient to address all the major challenges of teaching these curricula, including those within Māori-medium education, such as *pāngarau*, it was through the various discursive activities associated with these initiatives that further terminology and register development accelerated and became more systematic and planned.

The following chapter discusses the research methods used in this thesis to collect and analyse data that trace the development of the Māori-medium mathematics register in the modern era, and the methodology that is used to investigate the tensions and issues associated with corpus planning to elaborate an indigenous language such as *te reo Māori*.

Chapter 6. Research Paradigm, Methodology and Method

6.1 Introduction

This research is situated in the interrelated theoretical fields of sociolinguistics, LPP and education. The theoretical frameworks of LPP and SFL have been defined in Chapters 2 and 3 respectively and used to examine the development of *te reo Māori* broadly in Chapter 4 and *te reo Māori* in education in Chapter 5.

This chapter introduces the research paradigm, namely interpretivist, that influenced the research question chosen, i.e., “What are the key factors that have impacted on the development of the mathematics register for Māori-medium schooling and *te reo Māori* generally, the issues and tensions that have arisen as a result of this development and the implications for learning and teaching?”, and how the results are interpreted. To help investigate the development of the lexicon and register within their environmental context, narrative and case study approaches are used.

This chapter also discusses the methodology (also linked to the interpretivist paradigm), the overall approach to investigate the research question. This includes the scope of the research design, the rationale for selecting the informants and the case study schools, and also outlines how the data were analysed. While the interpretivist paradigm may lead a researcher to favour the qualitative data collection method (Silverman, 2010), quantitative methods are also in used in this thesis to more fully consider the research question. The final section includes a discussion about ethical issues.

This study also acknowledges that the researcher is not immune to being influenced by particular language ideologies, for example, linguistic purism and or changing beliefs about language standardisation. Hence, this research does not aim to be an “ideology-free” sociolinguistic study and I do not attempt to make myself invisible as the researcher. Instead, a reflexive sociolinguistics is drawn on that acknowledges its own interests.

Here “reflexivity” refers to an awareness of the researcher's contribution to the construction of meanings throughout the research process, and an acknowledgement of the impossibility of remaining “outside of” one’s subject matter while conducting research (Denzin & Lincoln, 2005). Limitations of qualitative/interpretivist research in regard to this thesis are discussed in Chapter 10.

6.2 The Interpretive Research Paradigm

During the late 1960s and throughout the 1970s, a new critical form of inquiry began to emerge as an alternative view to positivist social sciences (Burns, 2000). Earlier science paradigms were questioned and contested, and new ways of research adopted. This change was promulgated by a number of researchers who viewed human behaviour as understood only by the researcher sharing their frame of reference from this perspective. In this view, the understanding of individuals’ interpretations of the world around them has to come from the inside, not the outside (Lincoln & Guba, 1990). Thus, in stark contrast to positivism, interpretivist research has been characterised by a different set of assumptions: epistemological (e.g., subjectivist, knower and known are inseparable), ontological (e.g., relativism), axiological (e.g., value-bound), methodological (e.g., dialectical, hermeneutical), and rhetorical (e.g., informal writing style using personal voice and limited definitions; Denzin & Lincoln, 2005).

Social science is thus seen as more of a subjective than an objective undertaking, as a means of understanding people’s experience in specific contexts (Cohen et al., 2003). As an alternative to positivist approaches, these naturalistic and interpretivist approaches can be characterised by the following broad features: they include people who actively construct their own world (they are not passive recipients of positivism); situations are fluid and changing rather than fixed and static; events and individuals are unique and largely not able to be generalised; and there are multiple interpretations and perspectives of events and reality is multi-layered.

The interpretivist researcher tends to rely upon the “participants’ views of the situation being studied” (Creswell, 2012, p .8) and recognises the impact on the research of their own background and experiences.

Interpretivist research offers insights into an understanding of participants' views and behaviours, and differs from positivist research by giving consideration to contexts (Stake, 2010). Interpretivist researchers justify such an approach by suggesting that it is not possible to separate the context or setting in which the phenomenon occurs from the phenomenon itself (Morse & Field, 1996). This is consistent with one of the major assumptions of SFL. A central notion of SFL is the social context. SFL looks at how language both acts on and is constrained by the social context (see Chapter 3).

6.3 Interpretivist Research: Features of this Study

The following section examines the common characteristics and procedures of different types of interpretivist research that are adopted in this investigation.

6.3.1 Contextualisation

Most researchers working in the interpretivist paradigm conduct research from the perspective that researchers must be sensitive to the context of the research and immerse themselves in the setting and situation (Hammersley & Atkinson, 1995). The context of participants' lives or work affects their behaviour, and researchers have realised that participants are inevitably grounded in their history. The context could be a physical location such as a school and its role in language revitalisation (Creswell, 2012), which is the case in this study. In a broader sense, the context also includes economic, political and cultural conditions that impact on language revitalisation (Delamont & Atkinson, 1995; cf. Chapter 2). The context in this thesis also includes the multiple levels of language planning in relation to *te reo Māori*. The issue of context is highlighted by researchers of mathematics teaching from critical perspectives, who are increasingly focused on the social context of the mathematics classroom (Atweh, Bleicher, & Cooper, 1998). The school and classroom context is intrinsically related to the general sociocultural context that gives rise to the culturally constructed and valued knowledge called mathematics.¹⁶

¹⁶ For further discussion regarding the link between culture and mathematics, see Bishop (1991) and D'Ambrosio (1985).

6.3.2 Immersion in the setting

Most Interpretivist research investigates patterns of interaction, seeks knowledge about a group or culture or explores the worldview of individuals (Hammersley & Atkinson, 1995). Therefore, the researcher has direct contact with and gets close to the people, situation and phenomenon under study; the researcher's personal experiences and insights are an important part of the inquiry and critical to understanding the phenomenon (Hammersley & Atkinson, 1995). As is the case for this thesis, as a mathematics educator carrying out research, I am part of the setting I am investigating and know it well.

6.3.3 Voice, perspective and reflexivity

Since the researcher is the primary "instrument" of data collection and analysis, reflexivity is deemed essential (Merriam, 1998; Stake, 2010). This entails careful consideration of the phenomenon under study, as well as the ways a researcher's own assumptions and behaviour may be impacting the inquiry (Stake, 2010). The interpretivist researcher is reflective about his/her own voice and perspective. Researchers thus need to position themselves within their research study and identify their standpoint or view (Creswell, 2012). This is not inconsistent with the view of a number of contemporary writers in mathematics education who have argued that reflection is a critical characteristic of exemplary teachers (Rodgers, 2002). The call for reflexivity has also reached sociolinguistic researchers. Blommaert et al. (2001) called for the ethical and political dimensions of the researcher's work to be considered in ethnographic studies, arguing that language research itself is a historically and politically situated enterprise.

6.4 Narrative Inquiry

Narrative is inherently multidisciplinary, and is an extension of the interpretive approaches in social sciences. "Interpretive research" is a form of field research methodology that gives the researcher greater scope to address issues of influence and impact, and to ask questions such as "why" and "how" particular trajectories such as corpus planning were created (Klein & Myers, 1999). Narrative is an interpretive approach in the

social sciences and involves using storytelling (e.g., life histories, narrative interviews, journals, diaries, memoirs, autobiographies, biographies) and reporting that kind of research (Schwandt, 2007, p. 204). The story becomes an object of study, focusing on how individuals or groups make sense of events and actions in their lives.

The major characteristics of narrative research described by Creswell (2012, p. 507) that relate directly to this study include:

- Experiences of an individual. For this study, a number of participants were interviewed on their roles in supporting the development of the *pāngarau* register.
- Chronology of experiences. This includes examining people's behaviour, how processes and attitudes have changed, including historical evidence. (Chapter 7 provides a chronology of events describing the stages of development of the mathematics terms.)
- Life stories. In one sense, the story of the development of terms and the history of Māori-medium education is synonymous with the educational experiences of a number of the informants.
- Coding the field texts for themes or categories. (This is captured in Chapter 8.)
- Incorporating the context or place into the stories or themes. This is highlighted in the story of *te reo Māori* loss and subsequent revitalisation, discussed in Chapter 5.
- Collaboration between the researcher and the informants. I have personally worked with all the informants for approximately 20 years in a number of *pāngarau* schooling projects at the national and local levels.

Researchers capture informants' stories through ethnographic techniques such as observation and interviews. One key example of narrative inquiry used in this study is the focus in Chapter 7 on a key group of Māori-medium mathematics educators, Te Ohu Pāngarau (see Section 7.8.2), whose involvement with, and stories about, the development of the standardised corpus of *pāngarau* terms are central to the concerns of this thesis. Significant extracts of their narratives are included in Chapter 7.

6.5 Case Study Approach

One of the additional research aims of this study was to examine the role of various language users—that is, *kura* (school) principals and teachers—in order to try to reveal the ways in which users “take up” sociolinguistic norms and implications for future LPP planning. In this context, this study examines the interplay between macro/meso processes of mathematics lexicon standardisation and micro processes of language management in *kura*. Consequently, principals from two Māori-medium *kura* were interviewed, and teachers’ views of how they have learnt the *pāngarau* lexicon and register were also considered using a case study approach (see Chapter 8).

A case study is an analysis of an individual unit (e.g., a person, group, a country or event) stressing developmental factors in relation to context (Flyvberg, 2011). According to Stake (2010), “case study is the study of the particularity and complexity of a single case, coming to understand its activity within important circumstances” (p. xi). Yin (1994), along with Stake (2010), who are considered two of the seminal writers in this area, have defined a case study as an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundary between the phenomenon (learning of the register) and context are not clearly defined.

Yin (1993) distinguished three types of case study: exploratory, casual and descriptive. In an exploratory case study, the collection of data occurs before theories or specific research questions are formulated. The casual case study will look for cause-and-effect relationships. The descriptive case study will require a theory to guide the collection of data and the theory should be openly stated in advance (Yin, 1993, p. 22). This particular study is descriptive. Stake (1995) included three other variants: “intrinsic”—when the researcher has an interest in the case; “instrumental”—when the case is used to understand more than what is obvious to the observer; and “collective”—when a group of cases is studied. This current study uses both an intrinsic and an instrumental case study approach.

While case studies are generally associated with interpretivist research, they can also be used as a method of inquiry employing a positivist epistemology. This is the case in this study, in which quantitative research methods are used to illuminate teachers' demographic data. Flyvberg (2011) also pointed out that case studies frequently contain a strong element of narrative, which is also the case for this study, in which the school principals of the two case study *kura* provide a narrative of the history of their schools and language plans.

Case study research has been subject to criticism on the grounds of non-representativeness and a lack of statistical generalisability. Moreover, the richness and complexity of the data collected means that the data are often open to different interpretations and potential "researcher bias" (Cornford & Smithson, 1996). Despite these limitations, Stake (1995, 2010) and Yin (1993, 1994) still argue that case studies are useful in developing and refining generalisable concepts.

6.6 Research Methodology and Method

Some texts use the terms research paradigm and research methodology interchangeably and others use them as having different meanings. As discussed earlier, the use of the term 'paradigm' in this thesis is reserved for the philosophical intent. Similarly, method and methodology are often used interchangeably in research and are sometimes used to refer to the same concept. According to Burns and Grove (2001), "methodology" includes the design, setting, sample, methodological limitations and data collection and analysis techniques in a study. Brewer (2000) argued that "method", on the other hand, generally refers to the tools a researcher might use to gather data, for example, interviews, questionnaires, observation and so on, and to the process by which the collected data are analysed.

This thesis supports the definition that suggests that *methodology* is the overall approach to the research linked to the paradigm, while the *method* refers to systematic modes, procedures or tools used for collection and analysis of data. However, research methods are an integral component of

methodology rather than the next phase in the research process, or something distinct from it (Silverman, 2010).

6.6.1 Research methods

As noted, educational research traditionally followed the empirical “objective scientific model” (Burns, 2000, p. 3) which utilised quantitative methods of data collection, analysis and reporting modes. More recently, research approaches have become more complex in design and more flexible in their application of methods with mixed-methods being more acceptable and common (Creswell, 2012). However, this may not sit comfortably with researchers who are strongly aligned with a particular approach to research. As a researcher, I am not wedded to one particular method, and view qualitative and quantitative methods as complementary even though they may produce different outcomes. While this thesis predominately utilises qualitative data, I argue that quantitative data is also useful for the research to be more effective.

6.6.2 Data sources

The aim of this current research was to better understand the tensions, issues and ideologies associated with the initiatives, first, to develop lexicon to teach mathematics in Māori-medium schooling, and second, how it is being learnt and used by teachers. To assist with answering the research question, data were collected from two major sources: a key group of Māori-medium mathematics educators (Te Ohu Pāngarau) and principals and teachers in two case study schools.

6.6.3 Data from key informants involved in the development process (Te Ohu Pāngarau)

The first participant data source is three key informants, a group of mathematics educators who have had various roles in the creation of the new terms, the standardisation of the *pāngarau* lexicon and elaboration of the register. There were other individuals who have been involved intermittently and development teams such as the early standardising group and the curriculum development team have variously consisted of between 5–15 teachers and/or curriculum experts. However, these three informants have been significantly involved in the process of the early

lexical creation and standardisation when norms of codification were first established. Sadly, a number of people who may have been considered as informants for this thesis have since passed on.

This key informant group is referred to as Te Ohu Pāngarau. *Ohu* traditionally refers to either a communal or volunteer work group (Williams, 1975b). The use of the term Te Ohu Pāngarau in this thesis is a modern interpretation of the concept. The three key informants consented to participate in semi-structured interviews. Semi-structured interviewing is perhaps the most common type of interview used in qualitative social research (see Lindlof & Taylor, 2002; Silverman, 2010). It is a flexible interview in which the interviewer follows some guiding questions and responds to answers (see Appendix E for a list of the indicative questions). As noted previously, significant extracts of the informants' narratives are included in Chapter 7 as part of the narrative approach.

Following are brief profiles of the three key informants. Additional information on their work histories can be found in Chapter 7, along with explanations of how, as L2 learners, they learnt *te reo Māori* and became involved in the development of the pāngarau lexicon.

Informant 1 is Māori in his 50s. Formerly a secondary school immersion mathematics teacher, he is now principal of a *kura kaupapa Māori* and *wharekura* and has been involved in *pāngarau* corpus development over the past 20 years as a practising teacher, linguist and mathematics educator. He has played a major role as a practising classroom mathematics teacher in testing the linguistic and mathematical integrity of the terms and the register in day-to-day classroom discourse. He was also singularly responsible for coining a number of the new terms that have since become accepted as part of the standardised corpus of terms.

Informant 2 is Pākehā (European New Zealander) also in his 50s. He was also a former teacher in a bilingual secondary school. He now manages his own publishing company, and has been instrumental in developing a range of *pāngarau* texts and dictionaries now in common use in schools. He also provides professional learning workshops to teachers and

pāngarau facilitators. His role over the years has been primarily to develop the *pāngarau* register in text (print) and to lead the resource development.

Informant 3 is also Pākehā and is now a professor of mathematics at a New Zealand university and in his 60s. He too was a former secondary school mathematics teacher, teaching bilingual mathematics for a period of time. He initiated the first research project into developing a more systematic process of collecting and standardising *pāngarau* terms.

Collecting the stories/narratives

The interviews with these members of Te Ohu Pāngarau were carried out in 2010 and focused on gathering data to examine the dominating influences of the political and historical experiences of those involved in the development process. The stories were captured on audiotape and subsequently transcribed to examine what the interviewees said about the context and era when significant *pāngarau* lexical and register development occurred. This thesis recognises and acknowledges many other individuals and groups who have been involved and have supported *pāngarau*, not just the three interviewed.

The three informants were selected on the following basis:

- They were key members of the development team that compiled the initial *pāngarau* glossaries and were heavily influential in the codification process of *pāngarau* terms in the late 1980s and early 1990s.
- They were members of the initial and or revised curriculum development teams throughout the 1990s and 2000s (see Te Tāhuhu o te Mātauranga, 2008b).
- Two of them were also part of the Māori-medium numeracy strategy (see Te Tāhuhu o te Mātauranga, 2011, 2012) and the development team that compiled the latest *pāngarau* dictionaries, as well as developed the associated teaching and learning resources (see Te Tāhuhu o te Mātauranga, 2004, 2010).

Analysis of narrative data

The key informants' stories were transcribed by independent transcribers. I listened to the stories and reread the transcriptions to check for accuracy. One of the main aims was to identify common themes, seminal events and policies that impacted on the development of the corpus of terms in some way. This formed the basis of the development of the chronology of the key stages of lexication and elaboration described in Chapter 7 and discussed in Chapter 9. The key informants' transcripts were also examined to identify the range of concerns and challenges they encountered in the development process.

6.6.4 Case study data: *Kura A* and *Kura B*

The second source of data are principals and teachers from two case study schools. They were selected because one of the aims of this study was to view LLP from the policy level (de facto LPP in this case) to the micro—teachers. This is based on Fishman's (2006) hypothesis, "Language planning is ultimately judged not by its small coterie of specialised language planners but, most crucially, by its intended consumers" (p. 2).

To make the project manageable, only two schools were selected from which to gather data on Māori language plans, and how teachers in the two schools learn (or have learnt) the *pāngarau* register. While only a small data set ($n=19$), this thesis argues that this group reasonably reflects the characteristics of the sector. To provide some contrast, one of the schools was tribal (*Kura A*); the other was a pan-tribal school (*Kura B*). Pan-tribal refers to the *kura* in major urban centres that have participating students from a range of tribes, often the result of earlier urban migration in the 1950s (see Chapters 5 and 6 for background information on the factors that have impacted on *te reo Māori* generally). The politics of tribalism tend to impact on these sorts of schools differently. *Kura* with strong tribal affiliations tend to be more concerned with issues of dialect than pan-tribal *kura*. Consideration is given to a possible link between people's concerns about dialects and the acceptance, or otherwise, of standardised terms. The second consideration was to choose a rural or

small town school in contrast to a school from a large city. Schools in rural areas or smaller towns or cities tend to be more closely affiliated to a tribe or *hapū* (subtribe) or *whānau*. Where the schools are situated may thus have an influence on *te reo Māori* language policy in the school. The principal selection criterion for both schools was that mathematics was taught in the medium of Māori from Year 1 to at least Year 8.

Informants *Kura A* and *B* principals

The principal from *Kura A* was male, and from *Kura B*, female. Both had extensive experience in English- and Māori-medium schooling. Both were also foundation principals of their respective schools and were significantly involved in leading the development of their schools from challenging beginnings.

The researcher visited both schools and interviewed the principals about the history of the school and the beliefs and decisions that informed the school's *te reo Māori* language plan. The principals' narratives were audio-recorded, transcribed and returned to the principals for comment and feedback. Significant extracts of the principals' narratives are included in Chapter 8 as part of the narrative approach. The language plans in the form of the school charter were discussed with the principals to identify how each school promoted *te reo Māori* and the primary philosophies that underpinned the school ethos.

Informants *Kura A* and *B* teachers

Nine teachers from *Kura A* and 10 teachers from *Kura B* participated in the study. The criteria for selection were the following:

- Teachers had taught mathematics exclusively in the medium of Māori to any group of Year 1–13 students;
- They consented to be part of this research study.

Data were gathered from the teachers using a questionnaire/survey (see Appendix F). The responses were analysed to find out:

- How and where teachers learnt the Māori-medium mathematics language;

- What strategies they used to learn the new standardised terms;
- Which standardised terms they accepted and which terms they did not (and why).

6.6.5 Consideration of ethics: *Kaupapa Māori*

When researching Māori schooling, an important component of methodology is consideration of ethics. For many in the Māori community, *kaupapa Māori* usually refers to an organisation or group that operates using Māori cultural values, such as *kura kaupapa Māori*, schools explicitly based on Māori language and cultural values (Eketone, 2008). Many of the early seminal writers on kaupapa Māori as a research discipline were closely associated with the *kura kaupapa Māori* schooling movement, such as Linda and Graham Smith. In education, the development of *kaupapa Māori* specifically began in response to the lack of programmes and processes within existing educational institutions. *Kaupapa Māori* initiatives are designed to reinforce, support or co-opt cultural aspirations in ways designed by Māori themselves (Smith, 1999). Many located within the *kaupapa Māori* paradigm are committed to making changes towards a more just and fair society for Māori. This links to the field of “language rights”, “linguistic rights” and/or “linguistic human rights” developed recently within language planning and sociolinguistics, as discussed in Chapter 2.

Accordingly, this study aimed to adhere to ethical principles drawn from *kaupapa Māori* research theory and elaborated on by others (for examples, see Bishop, Berryman, Cavanagh, & Teddy, 2007; Smith, 1999, 2005). These include:

- The establishment of key relationships with informants;
- The notion of reciprocity;
- Advancing language revitalisation.

Ngā whanaungatanga matua: Key relationships

I have established strong links with the participating *kura* (schools) discussed in this study, and in many cases, have built up professional

relationships with key participants and teachers in the study *kura* (schools) over a long period of time. Many in the Māori-medium movement, in particular, *kura kaupapa Māori*, are suspicious of research and are not always encouraging of it in their *kura*. This is unfortunate, particularly in the emerging field of indigenous schooling, where there is still much to learn. This negative response to research is primarily due to the varying deficit constructs that have been identified in reports and research about Māori over many years. Māori have been continually defined by the parameters of the European researcher lens, which has magnified a range of deficits, including race, environment, cultural deprivation related to intelligence and language, poverty and “at risk” discourses (Cooper, 2008), hence the importance of existing relationships as a basis for trust in the research process.

The notion of reciprocity

When asking schools and teachers to participate in any research project, another important consideration is the notion of reciprocity. The principles that underlie reciprocity are the obligations that exist between individuals and groups, and that reinforce the view that research must be a collaborative and reciprocal process. For example, how do individual teachers and the school directly benefit from the research process? The schools and teachers have benefited (and will continue to do so) over the years from participation in a range of professional learning and complementary research projects to do with *pāngarau* delivered by the researcher. I continue to work on collaborative research and professional learning development projects with the key informants.

The advancement of te reo Māori

While focusing on issues and tension in the modernising of the lexicon and elaborating of *te reo Māori* could be construed as operating from a negative perspective, this study supports the ongoing revitalisation of *te reo Māori* and improved outcomes for students as its *raison d'être*.

6.7 Summary

This chapter outlined the research paradigm, research methodology, strategies and design used in the study, including informants, data

collection tools and procedures, analytical methods and research reliability issues. In addition, a rationale of the research design was provided. A summary of this chapter is presented in Appendix E, highlighting the major decisions made in order to conduct this research work.

The next chapter draws on the narratives of key informants to chronicle the specific lexicon and register development for *pāngarau* in the modern era from both meso- and micro-level language planning perspectives.

Chapter 7. Key Informants' Narratives: *Pāngarau* Lexicon and Register Development Process

7.1 Introduction

This chapter chronicles the evolution of the *pāngarau* terminology and register development in the modern era, drawing on the narratives of three key informants (Te Ohu Pāngarau) involved in the process, supplemented by information from my own experiences as a lexicon and curriculum developer. (The research issues associated with my role as both an informant and the researcher are discussed in Chapter 10). In so doing, Kaplan and Baldauf's (2003) LPP model is utilised, in particular, the corpus planning goals of establishing norms of codification (standardisation) and elaboration (cultivation/functional development).

7.2 Te Ohu Pāngarau Group (Mathematics Working Group)

It was this group of teachers, primarily Informants 1–3 discussed below (see Chapter 6 also), with a few others, including myself, that comprised “Te Ohu Pāngarau” referred to in this thesis. The emergence of this group can be traced back to the early development of the secondary mathematics bilingual units in the 1980s. With no institutional support for Māori-medium mathematics at that time, the informants sought help from each other. This was a critical moment in the history of the development of Māori language terms for mathematics, when a “critical mass” of experienced teachers with a passion for *te reo Māori*, languages, mathematics and mathematics education were beginning to coalesce, and take responsibility for advancing the field, including coordinating the development of the lexicon.

7.2.1 The informants: Te Ohu Pāngarau

This first section records the three informants response to the following question, “Why and how did you became involved in early bilingual mathematics teaching in the 1980s?” It is important to note that Māori immersion had not fully evolved as a schooling option at that time. The account also includes my own experiences as a member of this group. The informants' responses (narrative) follow and are italicised.

Informant 1 (interviewed 27/10/2010)

There were a couple of factors. When I came back from overseas after spending most of my teenage years there and started university, I was learning Spanish and Chinese and then my nan said “come on, you should be learning Māori”. So I thought next year—it was like a duck to water really. So that was the first step into it—learning Māori at University. Before I started being involved in the language movement, I was always intrigued with new things, and new things related to language. I also enjoyed maths at high school. It was a heady time back then at Auckland University. Because I came back from overseas, I more actively wanted to know more about things, more than perhaps if I had been brought up here (New Zealand).

After university, I headed back to [city] and then met [his future wife] we had some children. Along came, hello, the kōhanga reo movement. We got sucked up into that in a big way about what we were going to do for our children. I convinced my wife to bring up our children in this rather unproven idea, making sure our children were brought up in Māori. She was not a speaker of Māori back then, but just had to get used to me you know speaking Māori all week and things like that and then with kōhanga you got further interested in the language. So I thought would kōhanga be enough? So I went to teachers college and I did social studies and Māori. As you know it was the usual combination and I was just thinking oh Maori, wasn't enough you know. Little reo (language) exercises out of Te Rangatahi.

So I was glad to get a job at [school] Boys High where they had the beginnings of a secondary bilingual programme. I enjoyed it to start with, but as soon as I knew how to be a teacher, you realise it's not enough. You teach Maori on Monday and then here and there rest of the week. I thought this is not enough. I thought, why not teach maths in Māori? I thought that's a big thing to do, too many words we did not have. I hooked up with other bilingual maths teachers—it was a sense of doing something new and different, it was exciting. I think I grew with it. I think it must be hard for some teachers who come into the kaupapa late, they get hit with this great big corpus of new terms.

Informant 2 (Interviewed 14/2/2010)

I have a background in teaching from the early 1980s. I helped establish a secondary bilingual unit, forms 1–7 at [town] College. This was at about the same time [person] was establishing a bilingual unit at [school] High. Part of my role was teaching pāngarau, although I taught other subjects as well. I taught SC (School Certificate) maths but more bilingually¹⁷ than in the medium of Māori. Our experience was that often we would create resources and terms the night before on the hop, doing it yourself—although I worked collaboratively with [name deleted] from time to time. I also went to the bilingual hui. I was always interested in learning Māori. I went with Dad to marae. Eventually I went to teachers college when the opportunity presented itself to learn Māori. I came under the influence of [person] and other Māori lecturers. They often went out into the community with us students.

I left teaching to return to teachers college as a lecturer. My hope was that student teachers would not have to repeat my challenges. I also did some work at a national level. I saw a need in the specialist areas like pūtaiao

¹⁷ See earlier discussion in Section 6.4.1 on the interpretation of bilingual education in NZ.

(science) and *pāngarau* (mathematics). My mentor was [person] from the time at [town] College teaching in the bilingual unit. We fed off each other—stoked the fire in my belly to support the kaupapa. She left Otaki to work for the Ministry of Education. I left for teachers college and [town] University. [person] led the initial Māori-medium curriculum development on behalf of the Ministry of Education and pulled me in on the *pāngarau* advisory group. I did maths all the way through school—it became a strength of mine.

What I am really passionate about is the *kōrero* (talk). I heard a talk from Timoti (Kāretu) in 1984 to the *hui-a-tau* of the *Ataarangi* at Ruatoki. He said:

“Ko ngā kupu hou te oranga o te reo engari kia mau ki tā te Māori whakatakoranga” (The new words will ensure the survival of the Māori language, but they [the terms] follow the Māori syntactic form.)

This has influenced my own practice. It is important we consider te reo Māori ways of saying things. The grammar structure is integral to Māori language, rather than bringing English-language phrases into te reo Māori. For example, children using “kua” for “it’s complete or finished”. “Kua” is a verbal particle and they (children) drop off the verb. (This makes the sentence ungrammatical.) Once I started to understand that all effort would result in language loss if integrated into English-language structures, this became for me a driving consideration. As a second-language learner, I strive to speak and write Māori that contains structure integral to maintaining the integrity of the language.

Informant 3 (Interviewed 15/3/2010)

I came back from four years in Africa with an awareness of the importance of language that I did not have before. I realised that if I was to keep teaching in Aotearoa/NZ, I needed to learn te reo Māori, as a kind of moral imperative. I was still young and idealistic. So I embarked on learning Māori at polytechnic courses and enjoyed it and wanted to do it properly and so on. But then [person] set up the secondary bilingual unit. I do not remember the exact timing of everything there. I think it was 1987. But whether the unit was there already or not I can’t remember. But I became involved and volunteered to teach the maths, because no one else was around. What’s more, the [Māori-speaking family] came to live with us so it was part of my home life as well. Learning Māori. I was really immersed in it. So that then became part of my working and personal life. So I was kind of living and breathing bilingual stuff over that time.

All three informants were secondary mathematics teachers with an interest in *te reo Māori* and were at the forefront of teaching in bilingual units in the 1980s. It was at the secondary level where there was greater need for the specialised corpus of terms. Up to this point in time, very few *pāngarau* terms existed at the secondary level. Bilingual teaching emerged in the 1980s in primary schools. As teaching progresses through levels, mathematics becomes more complex, abstract and specialised with a greater need for specialised terms. At the primary level in the 1980s, many teachers were able to get by on transliterations, and terms used in day to

day *te reo Māori* and glossaries of terms developed by their respective communities. It is not surprising then, that the push for a standardised corpus of terms was from the secondary area.

7.3 Lexication, Codification and Elaboration of *Pāngarau* Terms

The following section examines the responses the key informants gave to a series of questions (See Appendix F). To give the responses of the three key informants a coherent structure, the data are organised into three main stages of LLP development according to Kaplan and Baldauf (1997). This includes Stage 1: Micro-corpus planning 1980s; Stage 2: Codification and Standardisation; and Stage 3: Language elaboration and cultivation. Informants' responses are italicised.

7.3.1 Stage 1: Micro-corpus planning 1980s: Informal lexical codification

The impetus to teach all subjects bilingually in the modern era began largely in rural areas in the late 1970s and early 1980s with the bottom-up demands of teachers, schools and communities (Benton, 1981). This created an urgent need for *te reo Māori* mathematics vocabulary at the local school level.

These word lists were not formally published, but were disseminated to some degree to relatives and friends in other bilingual schools and classrooms, which was often the practice in Māori education. (Informant 3)

The initial response was thus largely an ad hoc coining of words by teachers and *kaumātua* (elders), using whatever word creation strategy was available to each group.

I really enjoyed the organic nature in the beginning because some words fell flat on their faces—some words did not work. I used some words because they sounded good—not sure if they were right pedagogically. I like Māori oral literature—I was able to lean on a good word bank—lots of those words originally meant something different in relation to what we were doing in mathematics. (Informant 1)

Our experience was that often we would create resources and terms the night before, on the hop, doing it yourself. (Informant 2)

Teachers would find a word that is in use in everyday conversation and try and use it in mathematics. They would go around and around in a convoluted way. The cognitive shift did not happen. (Informant 3)

This is not that far removed from my own experience of creating terms in my secondary school bilingual class at the time. Often I would create terms for a particular lesson, and by the time the next lesson came around a few days later, I would have forgotten what I had used previously. Fortunately, on most occasions, the students would have a record in their books from the previous lessons and/or remember the names for the terms. (Researcher)

In the early bilingual schools, such vocabulary development was largely informal, involving elders, teachers and community working together to establish a corpus of terms for daily classroom use.

This mode of classroom imperative, rather than any formal language planning approach, has formed the basis for much of the early development of the pāngarau corpus of terms. (Informant 3)

This form of unplanned language planning was characterised by teachers actively creating terms to meet their lexical needs, not by any formal committee. In the absence of a central authority, corpus development could be seen as “micro-language planning” in which potential users constituted language planning agents, active in language planning for individual schools.

With the growth in primary bilingual schools and primary and secondary bilingual classrooms in the 1980s, more formal attempts were made to expand the word lists to include a greater range of terms. This included the translation of a picture dictionary, which was used routinely by teachers (including myself) in the absence of any other linguistic guide (see Cleave, Mataira, & Pere, 1978).

By 1983, the first bilingual classes in secondary schools were established, and by the mid-1980s, all the informants for this chapter were attempting to teach mathematics bilingually in secondary schools. No formal glossary of terms was available. In response to the growing demand for resources, the Ministry of Education seconded Toby Rikihana, a primary school principal and native *te reo Māori* speaker, to collate and produce a mathematics vocabulary glossary, mainly for the primary school sector (see Rikihana, 1988).

Toby Rikihana was the person initially responsible—getting together groups of experts. Look at where we have come from. (Informant 2)

The Rikihana (1988) text still contained transliterations (for example, *kaute* meaning count), a strategy for creating terms that was eventually rejected as a result of a growing preference for linguistic purism, led by Te Taura Whiri and Te Ohu Pāngarau, as discussed in the next section.

7.3.2 Stage 2: Macro/meso-level codification and standardisation

Te Taura Whiri, the agency that was to play a significant role in early terminology development for new domains, including Māori-medium schooling, had been created as an outcome of the 1987 Language Act. One of the roles of Te Taura Whiri was to create and/or support the creation of a corpus of terms for the curriculum areas. By the early 1990s, the proliferation of localised mathematics word lists from the regions and the publication of different word lists¹⁸ raised educational and Māori language change issues on a national scale.

I was asked to collate the terms in current use in schools, and to identify the gaps and to present the terms to Te Taura Whiri for discussion. We had no theoretical base to guide the creation of terms and no linguistic brief, and I think we were aware of it. I organised a number of meetings around the country with people I knew who were involved in teaching mathematics in bilingual classes. My memory is that it was then we sought Te Taura Whiri advice. We wrote a report to Te Taura Whiri and said “here’s what we have found, now what?” This led to a meeting between Te Taura Whiri and us to discuss the (many different) terms used by different schools and regions and by the few publications that had emerged. Both groups had definite ideas about the principles to guide the creation of the new terminology. (Informant 3)

The first set of principles, initiated by Te Taura Whiri, stipulated that words must not be loanwords from English and must be short and transparent (Harlow, 1993).

I remember that one of their (Te Taura Whiri) key tasks was to standardise the Māori-medium school mathematics vocabulary up to Year 10. (Informant 1)

The second set of principles was advocated by Te Ohu Pāngarau members concerned with showing the interrelatedness between terms.

Because the set of mathematical terms was a structured group of interrelated words, we thought it would be practical to show these relationships in the terms themselves. There was a lot of data and a lot of

¹⁸ For example, Barton and Cleave (1989) and Rikihana (1988).

alternatives for many of the words and I think that idea of the whakapapa (schemata-genealogy) came up. (Informant 3)

Te Taura Whiri members who were present at that *hui* (meeting) expressed concern that some words in the list developed informally were clearly unsuitable and broke the commission's guidelines for good terminology development practice.

Some of the tensions were probably highlighted in the meetings with Te Taura Whiri about some of the words that were coined were possibly leading to the encouragement of incorrect use of grammar outside the maths classroom. You know we had tauake (positive number) and tauiho (negative number), as positive and negative. (Informant 1)

Ake and iho are directional particles that, among other things, indicate an up-and-down direction. However, students were adding them to terms such as kōrero ake—to mean positive talk. In everyday te reo Māori, kōrero ake actually means to talk in an upward direction. (Informant 1)

Te Ohu Pāngarau group members also had concerns, but for different reasons.

From memory, these included concerns about some terms with dubious meanings, such as reta whakahoki for variable (letter as an answer—however, algebra uses letters to represent unknown quantities), and the lack of an obvious linguistic relationship between terms that were clearly mathematically related. (Informant 3)

Both Te Taura Whiri members and Te Ohu Pāngarau agreed to try to standardise one list for use in government agency publications, and as a reference point for teachers in an ongoing process of development. Haugen (1983) referred to this aspect of corpus planning as codification (standardisation).

I suggest that there were two standardisation activities in the creation of the *pāngarau* lexicon. One was standardisation of the principles governing the coining of new words (establishing sociolinguistic norms—Te Taura Whiri's primary responsibility), and the second, the standardisation of the specialised terms themselves. One does not always necessarily lead to the other, but in the case of the lexication of *pāngarau* it has. For example, Informant 3 asserted that:

We set up five principles: pāngarau terms should be consistent with each other, terms to be as short as possible, words should sound correct to a native speaker, usage to be grammatically correct that was done at one of Te Taura Whiri meetings, probably the first one. These principles have

proved to be really robust principles actually and it was interesting they did survive the rigours or crucible of what was going on. This was the first time that an attempt was also made to formalise Māori syntactic structures to express mathematical meaning. (Informant 3)

These principles are still very much the norm for the development of new terms (see Te Tāhuhu o te Mātauranga, 2010) despite the challenge laid down by iwi groups to protect their unique dialect (see Section 9.3.1 for further discussion).

The informants were also asked what were their retrospective views of the codification (standardising) process.

I guess one of the paradoxes is that, whether we liked it or not, we were standardising the language, which in our view had some benefits around children being able to move from school to school and still being able to do state exams. This is the negative effect of standardising a language—you impinge on dialect and all that kind of stuff, you know, you change the language. Whether you like it or not, one of the results was Māori language change. (Informant 1)

We needed some form of standardisation because of the resources for teachers. The Ministry of Education would not fund the development of resources for specific curriculum areas that used different terms. I think from memory, we argued strongly with members of Te Taura Whiri that any dictionary should have in its preface—this is recommended but it's a work in progress. I support the standardisation of technical terms and I support dialects. One should not necessarily interfere with the other. (Informant 2)

Despite the optimism of Informant 2, the tension between the standardising of a language and maintenance of the various *te reo Māori* dialects remains to this day. In 1990, at a meeting to standardise the terms, a particularly significant decision was made by Te Taura Whiri and supported by Te Ohu Pāngarau to purge *te reo Māori* of the various transliterated mathematics terms (an example of linguistic purism ideology see Section 9.3.2). As Informant 3 observed:

*The number terms used at that time included transliterations such as *numa* (number), *kaute* (from “count”), *whika* (from “figure”). They were all purged and the term “*tau*” only was adopted for number. It was agreed to use the standard Western mathematics notational system, visual representations, for example, graphs, etc., that all go to make up the mathematics register, and to continue to use proper nouns such as *Pythagoras*—so [the] theorem of *Pythagoras* became “*Ture a Pythagoras*”. (Informant 3)*

All the number-related words could be prefixed with *tau*. For example, multiple became *taurea* (*tau*—number, *rea*—multiply) and *taurua* (*tau*—number, *rua*—second/two) for even numbers. The view was that this

structure should be used so that the vocabulary reflected the subject matter.

By the way, the identification of tau for number has got to be the most brilliant thing that has ever happened. (Informant 3; this is because tau is the root word for over 48 different terms.)

It was in this 1991 publication, *Ngā Kupu Tikanga Pāngarau: Mathematics Vocabulary* (Ministry of Education, 1991) that *tau* was confirmed as the word for number (see Barton et al., 1995, for the full story on the term *tau*). At the time, a decision was also made not to standardise all terms but to keep a few options that were in common use, such as *whakarau* and *whakarea* to mean multiply (see Ministry of Education, 1991, p. 13). However, in subsequent developments, most of the variations, such as *whakarau* (multiply) were eliminated in preference for *whakarea* because *whakarea* did not have alternative meanings in *pāngarau*.

7.3.3 Stage 3: Language elaboration and cultivation

As noted in Chapter 5, from the mid-1990s to the present, *pāngarau* lexicon was closely linked with de facto LPP such as official New Zealand Ministry of Education resources, curriculum and teacher professional learning and development initiatives. As discussed in Chapter 5 also, by virtue of being a significant government policy imperative over the past 20 years, the mathematics education discipline in English-medium, and by default Māori medium, has been better funded than other curriculum areas, thus supporting a more robust infrastructure. This has also extended to *pāngarau*.

The development of a national *pāngarau* curriculum for Years 1–13 in the mid-1990s (Te Tāhuhu o te Mātauranga, 1996) required a considerable expansion of *pāngarau* terms, particularly for use in the upper secondary school. The expansion of terms was also encouraged by other ideological imperatives.

The writing of the first curriculum documents signalled the end of phase one. An issue was: is it useful to learn things in modern Māori?—that debate goes on. The first marau (curriculum) highlighted this issue. (Informant 2)

I think we developed that corpus of words for the curriculum not just because we needed them, but we set out to prove to many that we could do it. (Informant 1)

This not only included the specialised mathematics terms such as hyperbola (*pūwerewere*), but also the learning process terms that encouraged children (and teachers) to communicate mathematically. These included terms such as *tatari* (analyse), *whakahāngai* (apply), *whakamārama* (explain), *tautuhi* (define), which reflected key processes of learning underpinned by constructivist learning theories in which the emphasis is on the learner as an active “maker of meanings” (Steffe & Cobb, 1988).

Between 1990 and 1995, the glossary of terms had grown to over 400 terms (see Ministry of Education, 1991, 1995). As discussed in Chapter 5, in the mid-1990s, Te Taura Whiri refocused their resources on intergenerational language transmission initiatives, and second, institutions such as the Ministry of Education through their contractors had developed the capacity to continue corpus development.

One of disappointments of the recent corpus development has been the role of Te Taura Whiri. Initially they were proactive in corpus development during Timoti's (Kāretu, the first Māori Language Commissioner) time. Since Timoti's departure, not so. I think Te Taura Whiri should be involved in corpus development—it can be argued they did not always involve practitioners enough, but Te Taura Whiri gave their stamp of approval. (Informant 2)

From that point on, the process has been managed by Te Ohu Pāngarau group in conjunction with the Ministry of Education (see Chapter 10).

7.4 Expansion of the Corpus of Pāngarau Terms

The next section draws predominately on my own experiences as a participant in lexicon development, with some reference to the key informants. This is because I had a key role in the next significant expansion of the lexicon, between 2002 and 2008, as a result of the development of the Poutama Tau (Māori-medium numeracy—see previous chapter) project (Christensen, 2003) and the revision of the *pāngarau* curriculum (see Section 5.7.1) in 2006–2008 (see Te Tāhuhu o te Mātauranga, 2008a). Prior to the revision of the individual Māori-medium curriculum statements beginning in 2006, I was contracted by the

Ministry of Education to coordinate the standardisation of the cross-curriculum terms.

In the absence of a coordinated LPP for the development of the curricula for Māori-medium schooling in the 1990s, the various curricula were developed in isolation. There was a proliferation of new and different *te reo Māori* terms to describe learning processes and the structure of each curriculum (see Table 3). While not all the curriculum areas are shown here, what Table 3 illustrates is that, at times, administrative and political ideologies have impacted on corpus development.

Table 3. Māori-medium curricula synonyms

English-medium curriculum terms	Te Reo Māori (Māori language)	Pāngarau Mathematics	Pūtaiao (Science)	Hangarau (Technology)
evaluate	arotake	aromātai	aromatawai	arotake
explore	toro	torotoro	tūhura	hōpara
process	takinga	tukanga	tukanga	hātepe
identify	tautohu	tautuhi	tautohu	tāutu

Note: From Trinick (2006) Māori-medium curricula synonyms. Unpublished Report to the Ministry of Education. Wellington, NZ: Ministry of Education.

Ironically, the development of these new terms initially involved Te Taura Whiri. Under the direction of their first commissioner, Timoti Kāretu, and underpinned by an ideology of linguistic purity, they had used the opportunity to resurrect obsolete *te reo Māori* terms by changing meanings to fit the new meaning and context for schooling in the belief that by doing so they were better supporting the “revival” of the language. This seems to contradict their own policy of terminology standardisation (see also Chapter 8).

The task of standardising the cross-curricula terms was a challenge (Trinick, 2006). By 2006, the various curriculum revision teams were highly resistant to change. This was not surprising because, over the intervening 13 years of teaching practice and resource development, these terms had become embedded in curriculum discourse and/or had become favoured by users of specialised registers of the different learning areas. Fortunately, the lead writers of the various revisions were cognisant of the

anecdotal evidence of the linguistic challenges that the lack of standardisation across the various curriculum areas posed for teachers, both L2 learners and native speakers. Inevitably, it was the teachers who had to implement the different curriculum statements containing a range of technical *te reo Māori* terms for the same learning process at the classroom level. This is a good example of how LPP at the macro-level was used to implement the particular linguistic ideologies of Te Taura Whiri and the administrative ideology of the Ministry of Education, to the detriment of teaching at the micro-level. The linguistic overload was impinging on teachers' understanding of the curriculum content (Christensen, 2003, 2004). Despite some initial resistance in the meetings I managed, a standardised corpus of cross-curriculum and learning and teaching terms (Trinick, 2006) was eventually agreed to (see Te Tāhuhu o te Mātauranga, 2008b).

This range of corpus expansion activities eventually resulted in the need to revise the *pāngarau* dictionary (see Te Tāhuhu o te Mātauranga, 2010) to include the new terms and ideas. Each iteration in the expansion of the corpus of *pāngarau* terms has resulted in changes of terms also. For example, “finite” has been changed from *whai mutunga* to *mutunga*, a small grammatical change (see Te Tāhuhu o te Mātauranga, 2010, p. 52). According to Informant 1, “Ironically, some terms Te Ohu Pāngarau group speculated would not stand the test of time in the 1994 development have survived, and have now become normalised in *pāngarau* discourse”. For example, Te Ohu Pāngarau initially thought the term for data, *raraunga* (to catch, to gather), used by mathematics educators would be overtaken by *mōhiohio* (to know), the term used by the Māori language media at that time (Informant 3). However, this has not been the case; the term *raraunga* (data) prevails to this day.

7.5 Developing a *Pāngarau* Register

There was recognition early on in the development of *pāngarau* that the standardisation of a corpus of terms by itself was “not sufficient” support for teachers of *pāngarau*. This is consistent with Halliday’s (1978) argument that there is much more to the development of a mathematics register than just lexical expansion. What was also required were new

and/or different ways of expressing mathematical ideas and concepts in *te reo Māori*. In English, these forms of expressions have developed incrementally over time as an outcome of social interactions, including functional use in classrooms. The use of *te reo Māori* was banned and excluded from the classroom by government policy for over 100 years, so Māori have not had the luxury of a similar time frame to develop the mathematics register naturally. Consequently, in the modern era, groups such as Te Ohu Pāngarau have made a conscious and deliberate effort to accelerate the process, including the development of specific resources to exemplify and model syntactic structures.

7.6 Strategies to Develop and Normalise the *Pāngarau* Register

This section also draws on the narratives of the three key informants, supplemented by my own experiences, to examine the strategies that have been utilised to develop the *pāngarau* register. These have involved providing oral and written language models to talk about specific mathematics ideas. According to Informant 2:

The primary motivation to provide language-focused resources was to support teachers in Māori-medium education to use the language of mathematics to express mathematical ideas precisely.

7.6.1 The creation of glossaries and dictionaries

In the 1980s, the newly created terms were in the form of word lists produced locally, as distinct from later resources such as the glossaries (see Ministry of Education, 1991, 1995) and dictionaries (see Te Tāhuhu o te Mātauranga, 2004, 2010). The glossaries and dictionaries supported the development of the register by providing an explanation of the term and examples of the term in use. The production of the first *te reo Māori* mathematics dictionary (Te Tāhuhu o te Mātauranga, 2004) to capture the newly created corpus of terms was specifically designed for teachers and learners of *pāngarau*, and included several important features.

There were still gaps in the earlier papakupu (glossary). In the development of the latest iteration of the papakupu it was important to ensure there was an explanation of where terms came from. I experienced some teacher negativity with some terms. But by working with them to understand where terms came from helped them understand the process that tended to sway them toward supporting the standardised term. For example, “hau”, now

used for fraction, is an old word for “part left over”. It was not simply developed by some bright spark inventing new words. (Informant 2)

In the latest iteration of the dictionary (Te Tāhuhu o te Mātauranga, 2010), an example of the term used to communicate mathematically is provided with connections to related terms, for example, *Tuhia ētahi anō tapawhā, kia rearua te rahi ake i tēnei* (draw another square that is twice as big as this one). The aim was also to provide model syntactic structures to support teachers’ use of the formalised mathematics register.

There needed to be an explanation of the derivation. There also needed to be explanations and illustrations of application, for example, how the word is used grammatically. The whole reason was to encourage uptake by teachers in a considered manner, instead of a blanket rejection of the terms in an unconsidered manner. (Informant 2)

The dictionary also provided a taxonomy of questions that teachers could use (Te Tāhuhu o te Mātauranga, 2004, 2010).

This was based on my experience working with teachers who tended more often than not to ask low level questions, such as recall. The aim was to show how children’s learning could be enhanced through higher-order questions. (Informant 2)

To my knowledge, this dictionary feature was based on constructivist theories of learning (see Crooks, 1988, for discussions on these theories) and the development of cognitive academic language proficiency (see Cummins, 2007). According to Cummins (2007), academic language acquisition is not just the understanding of content-area vocabulary; it also includes skills such as comparing, classifying, synthesising, evaluating and inferring.

To cope with the expanded corpus of terms, the 2004 *pāngarau* dictionary (see Te Tāhuhu o te Mātauranga, 2004) was revised in 2010 (see Te Tāhuhu o te Mātauranga, 2010) by the Ministry of Education.

There are some new terms and there have been changes to the standardised terms. The term for degree (of an angle) changed. In the first edition of the dictionary, “tākiri” was offered with “putu” as an alternative. This has changed around and now “putu” is recommended. (Informant 2)

Ironically, *tākiri* is a transliteration of *degree*, but it escaped everyone’s attention when the 2004 version of the dictionary was developed. It was

eventually purged in the 2010 version, and “*putu*” traditionally used to mean at frequent intervals now dominates.

In many discussions on corpus planning, the establishment of a grammar and dictionary are seen as key outcomes of the corpus planning process (Haugen, 1983). Liddicoat (2005) argued that, for the purposes of language codification, the production of a dictionary encapsulating the norms of the newly codified language is important, as is the aim of the establishment of a single authoritative norm or reference for language generally. It was felt by members of Te Ohu Pāngarau that this was a critical aspect of the terminology development for *pāngarau* also (all informants).

7.6.2 Teaching and learning resources

Not only is there a range of resources to support the learning of the specialised *pāngarau* lexicon developed by the Ministry of Education, but there are language models of talking about mathematics as well.

Specific resources have been produced to exemplify syntactic structures, including oral and written language models to talk about specific mathematics ideas. (Informant 2)

As discussed previously, while the idea of multiplication and division in *te reo Māori* is not new, discussing the role of the numbers as multiplicands and multipliers in formal mathematics is. Consequently, the linguistic structures developed in the 1980s and 1990s to express multiplicative relationships have evolved to better reflect the difference in the role of numbers in equations according to their function (see Te Tāhuhu o te Mātauranga, 2010, p. 325). While the mathematical concept may be new in the vernacular, the developers used these opportunities to resurrect more traditional syntactic structures. For example, by the time of the early years of language revitalisation in the 1980s, the meaning and use of *ki* as a particle to mean “with, by means of” had fallen out of general *te reo Māori* use and had been replaced by *me* or *ma* (and). The reintroduction to the syntactic structure of the term *ki* in recognition of modern usage of numbers being multipliers thus supported two goals: the learning of mathematics and language purism. This is one of the many ironies of this development. While there has been criticism of the “new language”

(Reedy, 2000), the new language has supported the development of everyday *te reo Māori*, which is typically acquired naturally through social interaction. Because *te reo Māori* is still limited to a few domains, this is not necessarily occurring. Therefore, the mathematised language can recursively support the development of everyday vernacular usage—one of the wider goals of language revitalisation. Recursive, as used here, refers to its use in linguistics, meaning the repeated sequential use of a particular type of linguistic element or grammatical structure.

The following section highlights some of the conflicting tensions and issues that have arisen during these processes of development, and also the outcomes of these developments, from within Te Ohu Pāngarau group.

7.7 Tensions and Challenges

One of the questions posed to the key informants during the interviews focused specifically on the tensions and challenges of *pāngarau* developments (see Appendix F). Their responses can be grouped around the following themes and include:

- Teaching mathematics or teaching language?
- Language change: new terms
- Who has the authority to create new terms?
- Acceptance of new *pāngarau* terms.

7.7.1 Teaching mathematics or teaching language?

According to Informant 3, in the early period of development in the 1980s, there was some tension in secondary bilingual classrooms in regard to the role of the mathematics teacher in the language revival process. Initially, many *whānau* saw the acquisition of *te reo Māori* and *mātauranga* (knowledge) *Māori* as a more important goal than the acquisition of mathematics knowledge:

One of the issues going back to the community base we worked with was the issue “are we teaching the language or are we teaching the maths?” I was getting very mixed messages from the community at that time about that. It was certainly something I felt it was not my role to decide. On the one hand, I was in the bilingual unit in the late 80s. I was getting both messages depending on whom I was talking to in the school. At one stage I

was told “look, do not worry about the Māori, your Māori is not good enough anyway, just teach them the maths that is all we want”. That was one message and then I would talk to someone else in the community, for example, the parents. They would say “look I do not care about the maths, the language is the thing we are doing this for. Do the best you can.” (Informant 3)

In my discussions with leaders of *kura kaupapa Māori*, including its chair in 2013, this tension still exists and is exemplified in the debate about the introduction of Māori-medium national standards (*Ngā Whanaketanga*) for *pāngarau* (Rawiri Wright, personal communication, 25 June 2013). The Aotearoa/NZ version of national standards had its genesis in the 2008 general election campaign, in which the conservative National Party showcased the policy. It was promoted as the way to address student underachievement. While not underpinned by national testing, as is the practice in other countries, groups such as Te Rūnanga Nui o Ngā Kura Kaupapa Māori, rejected *Ngā Whanaketanga* (Māori-medium national standards), arguing that a heavy assessment culture leads to a narrowing of the curriculum (Māori Television, 2013). They feared that the emphasis on *Ngā Whanaketanga* would dilute the focus on *te reo Māori* revitalisation.

7.7.2 Language change: New terms

The issue of language change as an outcome of the elaboration of *te reo Māori* was a contentious topic of debate in the wider Māori community throughout the 1980s and 1990s (Harlow, 1993). It is not surprising, therefore, to hear that the informants involved in the development of the *pāngarau* lexicon were confronted with similar concerns:

Looking back, I think of some of the tensions highlighted in the meetings with Te Taura Whiri was that some of the words that were coined were leading to the encouragement of incorrect use of grammar outside of the maths class. I don't know if you remember, we had tauake and tauiho, as positive and negative. (Informant 3)

I think one of the things about with our group (4–5 people) was that everyone was really conscious of that balance and tension between making sure the language made it through relatively unscathed, whilst at the same time ensuring mathematics understanding. We wanted to make the meanings of words really clear. Like for instance, when we were talking about the taaroa for the hypotenuse. We really worked together to ensure not to include words that were so obscure. For example, some English-language terms, unless you were a speaker of Greek you could not interpret them using their linguistic meaning. These terms were developed in a time when most of the mathematicians spoke Greek and Latin anyway,

so the meaning of the words were probably clear to them then. (Informant 1)

7.7.3 Who has the *mana* (authority)?

One of the issues raised by the key informants was the issue of who determined the new lexicon at the national and local level, and who had the authority to create new terms on behalf of their respective language communities. As Informant 2 pointed out:

One of the disappointments of the recent corpus development has been the role of Te Taura Whiri, who was initially proactive in corpus development but subsequently withdrew. Consequently, there is no central government or Ministry of Education leadership. However, there is strong internal leadership from practitioners who are passionate about the curriculum area.

More recently, at the meso-level of *pāngarau* LPP, work has been primarily located with a few individuals—far more so than with Te Taura Whiri, the state agency charged with LPP responsibilities. The role and ethnicity of members of Te Ohu Pāngarau has also been a cause of tension, raised mainly by the individuals themselves rather than *te reo Māori* community, as the following comments exemplify:

One of the political issues was me as a Pākehā. I have been involved for over 30 years now. I have always been careful of my involvement. I had to be sensitive. I had to be aware my involvement needed support from the community of practitioners. If there was no support, I would not be involved. In hindsight, I may have overstepped the mark, but I have always been enthusiastic. (Informant 2)

The one that comes to mind was my own personal place in this development as a Pākehā in 1989. I think in those early days I did not question that too much. I suspect that was something that emerged slowly out of that. (Informant 3)

7.7.4 Acceptance of new *pāngarau* terms

One of the greatest challenges of the lexication of *pāngarau* terms was to convince the sector to accept the newly prescribed terms. The prescriptive nature of standardisation and codification is a double-edged sword. Standardisation was used in the lexication of the *pāngarau* terms in order to reduce the variation in terms that had initially been developed at the local (*iwi*/tribal) level.

One of the big challenges was to encourage the education sector to accept the new words. I feel aroha (sympathy) for our new and inexperienced teachers. There is now a vast corpus of new words they need to understand across all areas of the curriculum. Another big issue has been

the rapidness of language change. Our developments are resulting in rapid change in language because in the previous 150 years, development was held up for all sorts of historical reasons. When you have a period of rapid development after a long period of stagnation, there will be issues to do with the scale of change. If the language had been able to develop over time, there would have been an evolution rather than a revolution. There are over 600 new pāngarau words as part of the growth of the corpus. (Informant 2)

Teachers should not shy away from learning these terms—it has to be a language and teaching goal. We all struggled for years for the new words to become included in our corpus of use. (Informant 2)

There was general sympathy by all three informants as to the significant corpus of new terms to be learnt and the challenges this posed for teachers. However, there was also recognition that the development of new terminology for *pāngarau* and the development of the register will be continuous as the teaching of *pāngarau* evolves to meet the demands of modern usage.

In terms of the development of the corpus of terms for pāngarau it's been a pretty good process. I could say it should have happened 100 years ago but it has happened. There have been progressive iterations since the late 1970s, the early 80s through to the first edition of the dictionary in 2004, through to the second edition in 2010. (Informant 2)

7.8 Summary

This chapter has chronicled the creation, standardisation and elaboration of the *pāngarau* lexicon, in particular, in the modern era, utilising the narratives of key informants from Te Ohu Pāngarau as well as my own experiences as a curriculum developer and facilitator supporting schools to implement programmes such as Te Poutama Tau. The impetus for the corpus development of the Māori-medium terms has accelerated considerably since the 1980s, and continues to do so as new ideas and initiatives are introduced into *pāngarau* education. As an outcome of various education policy initiatives, there has been considerable corpus expansion—first, of *pāngarau* terms and, second, of the mathematics register—through the development of specialised resources and through functional use in the classroom. While it has taken several hundred years to develop the English-medium mathematics register, the Māori-medium mathematics lexicon and register has had to be developed in a short space of time to parallel what is expected in English-medium education,

including responding to the high status of mathematics in the Aotearoa/NZ schooling context and society in general.

A feature of the initial development of the *pāngarau* lexicon was the informal approach taken, involving *kaumātua* (elders), teachers and community working together to establish a corpus of appropriate terms, rather than any formal language planning approach. The initial strategy of creating or adopting new words for *pāngarau* was generally through the use of loanwords and borrowing terms. Expanding the language into new domains in this way came to an abrupt halt in the 1980s with the establishment of the state language planning agency, Te Taura Whiri, with an emphasis on linguistic purism and not borrowing terms as the basis for corpus development. Due to limitations in resources and expertise, Te Taura Whiri eventually withdrew from the process of developing the specialised lexicon for schooling and, in their absence, ongoing lexical development was entrusted to a group of Māori-medium mathematics educators (Te Ohu Pāngarau), although they, too, have been inevitably influenced by the emphasis on linguistic purism.

This chapter focused on the narratives of key informants to identify key chronological aspects of corpus development that have been closely linked to the Ministry of Education's numeracy strategies; how teachers learn these terms and what they think of the newly created corpus of terms is addressed in the next chapter.

Chapter 8. Case Study Data: Two Māori-Medium Schools

8.1 Introduction

This chapter draws on data in the form of narratives and interviews with principals and surveys with teachers in two Māori-medium case study schools. The aim was to examine LPP at the micro-level in the form of the schools' development as a sociolinguistic unit, their language plans and how their teachers learn and use the recently created *pāngarau* lexicon. Large extracts of the principals' narratives and teachers' demographic data and views on the *pāngarau* lexicon are provided because they are at the micro-level of LPP, such as schools, where policy is often realised (Baldauf, 2006; Fishman, 2006), and it necessarily includes the key work of principals and teachers.

8.2 Case Studies: Two Māori-medium Schools

The principals of the two case study schools in this current study were asked to provide a history of their school and give the rationale behind the school's language plan, if it had one. They are fluent in both English and Māori, one is male (*Kura A*) and one female (*Kura B*). While schools may not have an explicit "language plan", every state-funded school in Aotearoa/NZ is required to complete a school charter under the Education Act 1989 (see Ministry of Education, 2012). The purpose of the charter is to establish the mission, aims, objectives, directions and targets of the schools' board of trustees or governing body, and in Māori-medium schools, this will include *te reo Māori* achievement targets and *te reo Māori* policy. Teachers in these *kura* (schools) were asked to complete a questionnaire about their work history in Māori-medium education and their views and usage of the specialised *pāngarau* terms (see Appendix F for the list of questions).

8.2.1 Micro-level language planning – *Kura A*

Kura A is a *kura kaupapa Māori* with an attached *wharekura* (secondary school component). All teaching (except the teaching of English and a foreign language) is carried out in the medium of Māori, from Years 1 to

13. The school is located in a medium-sized Aotearoa/NZ city (population of 56,000) and has strong ties to the local *iwi* (tribe).

The tumuaki (principal) was asked to talk about the history of his *kura*. What follows is the principal's narrative:¹⁹

Tumuaki:

The impetus for the development of our kura came from a small group of parents, brought together by shared te reo Māori aspirations and who all had children attending three local kōhanga reo (Māori-medium preschool) in 1986.

The whānau were fully cognisant that once their children graduated from the kōhanga reo, opportunities for further Māori-medium education were extremely limited. Faced with intransigency from the local state schools to develop Māori-medium units and with the only other kura kaupapa Māori in the region having a full roll with little likelihood for future expansion, the whānau were encouraged by the strength of our own convictions to "create" our own school in 1992. This was a brave leap of faith in the early 1990s because Māori-medium education was in its infancy and the potential outcomes were yet to be realised. We had no dedicated school building, no money, and no support from state educational agencies.

Despite what must have been seen as overwhelming challenges at times, the whānau saw the potential in creating a school based on the revitalisation of Māori culture and language with the allied dimension of tino rangatiratanga (self-determination). The trustees of the marae, where one of the kōhanga reo was located, supported the retention of the children beyond preschool and agreed that a classroom could be established in the leaky dining room in 1993.

However, leaky dining rooms, let alone marae dining rooms, are not ideal long-term learning spaces, considering the challenges of the modern curriculum, and so the seven children started being "home schooled" in a garage belonging to a whānau member, while the dining room could be altered to provide a space more conducive to learning. Five months later, the school returned to the refurbished dining hall with 14 children from ages five to eight. There the school remained for the next five years, outside of the state education system, with parents providing most of the financial resources for such things as teachers' salaries, school operating costs, etc. However, with the growth in the student roll, more teachers were required to maintain a reasonable staff–student ratio, more purpose-built buildings were needed and, as a consequence, the financial burden became excessive. Consequently, the school whānau applied to the Ministry of Education and was accepted into the preparation and assessment process for establishment as a Section 155 Te Aho Matua kura kaupapa Māori as a kura teina²⁰ at the end of 1993.

¹⁹ The filler parts of speech; that is, pauses and "ums" and "ers" have been taken out of the narratives because they do not serve any purpose in this study.

²⁰ *Kura teina* is an off-site, satellite unit of, and mentored by, an existing *kura kaupapa Māori*, termed a *kura tuakana* for the purpose of Ministry of Education accreditation to be a state-funded school. In some cases, the *kura tuakana* are close by, in others, they are several hundred kilometres apart.

As a kura teina, the school had to withstand a range of rigorous audits and reviews to confirm it met all the various compliances to gain full state recognition, including critical state funding. The Education Review Office confirmed that the school met all these requirements and agreed to fund the long-awaited construction of a purpose-built school, much to our relief. The kura achieved full status in 1995.

Space for expansion of the kura was limited on the marae site, so the school had to move to a new location. Fortunately, tribal lands leased by the Ministry of Education were available close by and the school relocated to hastily constructed, prefabricated buildings not far from the original site. The school reopened in September 1998 on the new site with 37 children and three classrooms. (Tumuaki, Kura A)

Interviewer: Why is the kura the size it is now?

Tumuaki:

The initial plan was to limit the roll to no more than 72 students to maintain a high level of intimacy conducive to a whānau environment. However, the pressure of applications for enrolment and the desire to expand the curriculum base resulted in a steady increase in student numbers until the roll reached 207 students in 2010. This required a change in the building plans and over the following years more buildings were built than originally envisaged.

1992	1993	1995	1998	2010	2012
<i>Kura opened in garage with 7 students</i>	<i>Kura relocates to marae dining hall. Established as a kura teina</i>	<i>Kura achieves full licence to self-govern</i>	<i>Kura relocates to new dedicated site with 37 students</i>	<i>Kura expanded to cater for 207 students Years 1–13</i>	<i>Roll reaches 216</i>

In terms of management, prior to being a state-funded school, the kura was governed by our whānau, but as the school increased in size, and with state funding came the inevitable governance requirements of the state. This included the establishment of a board of trustees of parents and/or community representatives.

There were some misgivings about creating a board to represent “all” the whānau. Concerns were raised in regard to possible parent alienation from the school by the board and abrogation of parents’ responsibility towards their children’s education. I think some of the concerns have been realised. The previous high levels of commitment to the language and the culture by parents have waned. This is due to a number of factors, including fatigue by parents who have been involved in the constant te reo Māori revitalisation and maintenance struggle for many years. Whānau are more relaxed than they were in the 1980s about the vitality of the language, believing that the language is no longer in peril.

Many parents also saw themselves as change agents of the education system to ensure successful te reo Māori outcomes for their children,

amongst other things. Now that their ambitions had been realised, their advocacy role as change agents did not figure so greatly.

All subjects are taught in the medium of Māori. However, most students have English as their first language, but have learnt te reo Māori from kōhanga reo. Some parents are fluent Māori speakers, but not all, because many are from the generation when Māori was suppressed in schools, either formally or informally. Students begin formal English lessons in Year 7 and all learn a foreign language, from their first year at school. Multilingualism is celebrated and practiced in the kura and contributes to the students perceiving themselves as citizens of the world. The final goal is not in conflict with the first one; it simply recognises that Māori children live in a variety of complex contexts and the children in this school have enormous potential as future “cultural brokers”. (Tumuaki Kura A)

This school is an example of the outcome of the grassroots Māori language revitalisation initiatives of the early 1980s, and typifies the struggle and history of development of many *kura kaupapa Māori* (see Smith, 1999). However, it differs in one significant aspect from other *kura kaupapa*, in that a third language (Spanish) is also taught.

A group of parents associated with a *kōhanga* (Māori language ECE) resisted the assumption that their children would simply enrol at the local English-medium primary school. What followed then was this group of parent's attempts to set up a school, initially without state support to ensure the ongoing *te reo Māori* proficiency development of their children. This is a big challenge for parents, particularly so in the early years without state support. As noted by the principal, some parents were L2 learners of *te reo Māori*. It is not clear what the implications of this are for their children learning in the Māori-medium context.

Kura A. The principal was also asked to explain the school's language policy.

Tumuaki:

The Māori language policy of the school is based on te reo Māori-only principles of Te Aho Matua. Te reo Māori is the principal language of general communication and of teaching and learning. I have a strict rule that English is not to be spoken to students or in the presence of these students unless in the English-language-learning classroom. The reason behind this practice is the pervasive nature of English in the New Zealand context, including being the language of the home and social settings for many of our students. All the children are competent speakers of English. I only speak te reo Māori to the students in social and community settings. The aim is to model and to encourage our students and graduates to speak te reo Māori in domains other than schooling. They greet me in te reo Māori

in public. Parents are expected to communicate in te reo Māori with their children at home. If they are not very fluent, there is an expectation that they will participate in a te reo Māori learning programme of some sort. The school's enrolment policy is that only children from Māori-medium preschools, that is, kōhanga reo, are accepted. The kura also observes Māori traditions and principles in the classrooms in accordance with tikanga Māori (Māori custom). For example, students, visitors and teachers are asked to take their shoes off before stepping into the classrooms, and students and teachers are not permitted to sit on tables. (Tumuaki, Kura A)

The school strictly adheres to the separation of languages policy laid down by Te Aho Matua (see Section 5.5 for a brief description of the policy and its implications).

8.2.2 Micro-level language planning – Kura B

This *kura* is located in a large city (population 1.4 million) and provides Māori-medium education from Years 1 to 10.

The *tumuaki* (principal) was asked to talk about the history of her *kura*. What follows is the principal's narrative.

Tumuaki:

Although our kura is essentially pan-tribal (includes students from all tribes), it has close affiliations with local tangata whenua (people of the land) where the school is located. Most of the students and teachers are second or third generation descendants of the many Māori who migrated from their tribal, rural lands to the city in the 1940s and 1950s seeking work and greater educational opportunities, and typify the many families where there has been significant te reo Māori language loss. Their participation in our kura aimed to address this history of language shift and loss in their families.

We have had a chequered history, primarily because of the struggle for tino rangatiratanga (self-determination) and te reo Māori revitalisation for our Māori community, where previously there were none. The original school was a secondary school opened in 1975 as an English-medium school with te reo Māori as an optional subject. The school was an educational experiment to test community models of secondary school education in low socio-economic areas. Initially, the school population had a wide range of ethnicities, but the local area suffered significant 'white flight' during the late 1970s. From the 1950s to the 1970s, 'white flight'²¹ in areas of Aotearoa/NZ was a reaction to the mass urbanisation of Māori and Pacific Islanders.

In 1985, the school established a secondary school bilingual unit for Year 9 to 13 students out of concern for the significant te reo Māori shift that had occurred in the homes of Māori whānau (family/ies) in the school community.

²¹ Demographic term denoting a trend wherein Pākehā flee urban communities and schools as the minority brown-skinned population increases (Wylie, 1999).

The secondary bilingual unit became a Māori-medium unit in the early 1990s, with most subjects taught in the medium of Māori in Years 9 to 10 (the first two years of high school) and bilingually in Years 11 to 13. The secondary school and its attached Māori-medium unit were amalgamated with two other local English-medium schools in 1996, including a local primary and intermediate school. One part of the composite school became an English-medium school (Years 1 to 13), and the other, Māori-medium (Years 1 to 13).

Tumuaki:

In January 2011, the Māori-medium part of the composite school was re-established under Section 156 of the Education Act, as a special character school in its own right delivering Māori-medium education. This was a momentous occasion after many years of struggle to gain tino rangatiratanga (self-determination). We celebrated the opening on Thursday 3rd February 2011 with a dedication service attended by many dignitaries. We are enjoying the change in status and look forward to the many fruitful years ahead. Our vision is to develop individual and whānau excellence and creativity in a vibrant, respectful, and purposeful learning community to ultimately improve our ability to participate as Māori citizens of the world. (Tumuaki, Kura A)

1975	1985	1996	1997	2011	2013
<i>Kura opened as a community college (English-medium). Years 9–13</i>	<i>Kura establishes a secondary bilingual unit</i>	<i>Kura amalgamates with local primary and intermediate school</i>	<i>Māori-medium unit Years 1–13 breaks away from English-medium</i>	<i>Kura reformed as special character kura-a-iwi Years 1–13</i>	<i>Roll reaches 290</i>

Kura B. The principal was also asked to explain the school's language policy.

Tumuaki:

It is expected that prospective students have attended a kōhanga reo or similar early childhood (centre) or have had the necessary (Māori) language support of a minimum of three years prior to entry into school. Preference is given to children from the local tribal area, then children who have family at the school, and finally children from the local catchment area. In Years 1 to 10, learning and teaching is in the medium of Māori. English is introduced as a subject in Years 7 and 8 and more subjects are taught bilingually in Years 11 to 13, primarily because we struggle to find teachers proficient in te reo Māori with the required (secondary) curriculum content knowledge. (Tumuaki, kura B)

8.3 Teachers as Learners in Kura A and B: Demographic Data

A questionnaire was handed out to participating teachers in the two case study schools asking where and how they had learnt the specialised terms

and register (see Appendix F and the methodology chapter, Chapter 4). Teachers were also asked questions about their work histories, and in order to collect demographic data such as gender and age. The data from the two case study schools will be compared with the national demographic data and possible implications considered. While the corpus of demographic data collected to characterise Māori-medium teachers nationally is in its infancy, it is slowly expanding (see Ministry of Education, 2005; Murphy et al., 2008).

8.3.1 Teacher gender

While most teachers at mainstream primary schools in Aotearoa/NZ are female, the gender split is more even at secondary schools (Ministry of Education, 2005). Therefore, gender was chosen to examine whether Māori-medium (albeit only a small sample) was the same as the national norm as regards gender. The distribution in *Kura A* is reasonably typical of the situation in Aotearoa/NZ schools with twice as many females as males (see Ministry of Education, 2005). In contrast, *Kura B* had equal numbers of male and females. The distribution of teachers by gender is shown in Figure 1.

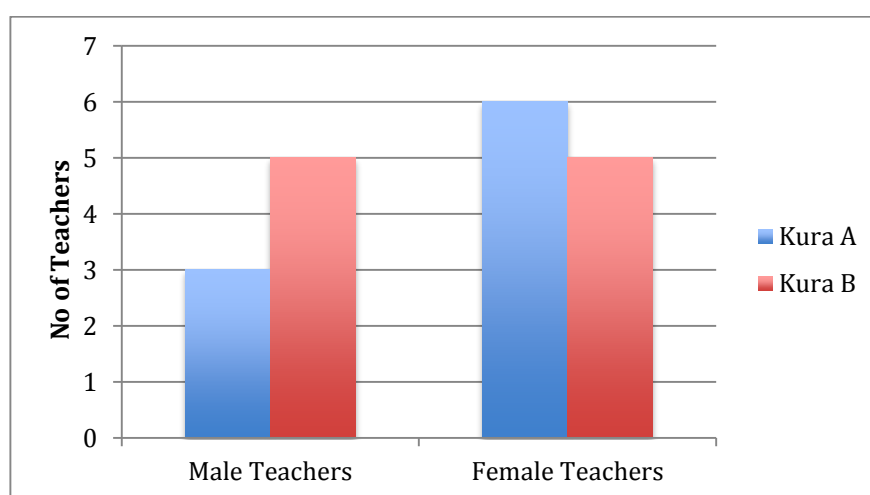


Figure 1. Proportion of teachers by gender in *Kura A* & *B*

Research undertaken by Te Puni Kōkiri (2002) shows that women are more likely than men to participate in formal *te reo Māori* education courses such as teaching (23% of women participated compared with 14% of men). However, there is no evidence that the gender of the teacher

made any difference to student achievement in subjects such as *pāngarau*.

8.3.2 Teacher age

Most of the teachers were in the three older age brackets, with the exception of three teachers from *Kura B*. This is again typical of the situation in Aotearoa/NZ generally, where over half of teachers (58%) are aged between 40 and 59 years (Ministry of Education, 2005). The distribution across age groups was very similar for female and male teachers.

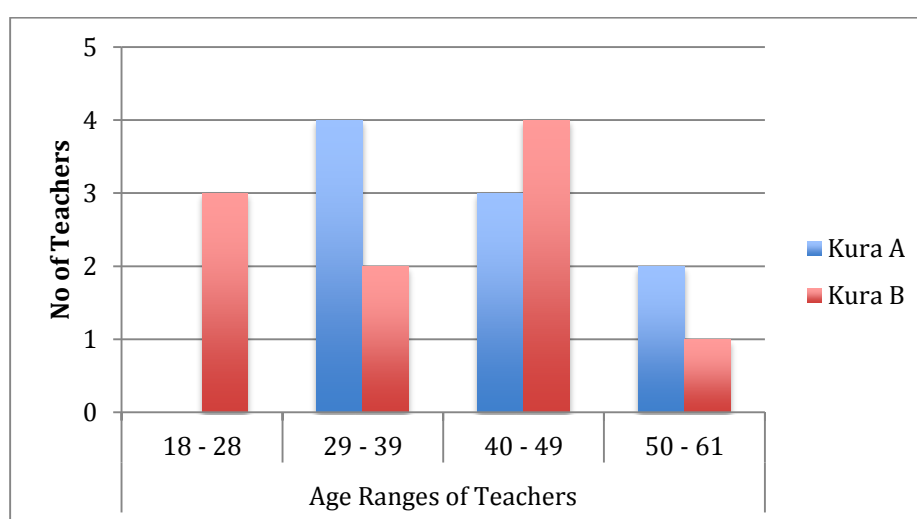


Figure 2. Proportion of teachers by age

It is a concern in English-medium schools (possibly in Māori-medium schools as well) that the age structure will have a direct impact on the loss rate (i.e., retirement, among other reasons) from the profession and the need to find sufficient replacements (Harker & Chapman, 2006).

8.3.3 Teachers as speakers of *te reo Māori*

All the teachers in *Kura B* who taught mathematics considered themselves L2 learners of *te reo Māori* (see Table 4). This is typical generally of the situation in Māori-medium education (see Murphy et al., 2008). However, *Kura A* was an exception to the national norm, probably because of its location in a rural provincial town surrounded by Māori tribal communities where *te reo Māori* is still relatively strong. Thus, *Kura A* has been able to draw on teachers who are native speakers from these rural communities

and who choose to live and work close to their *whānau* (families) in the nearby town.

Table 4. Teachers as native (L1) or second-language (L2) speakers of *te reo Māori*.

	L1	L2
<i>Kura A</i>	4	5
<i>Kura B</i>		10

8.3.4 Teaching experience

Both *kura* had very similar demographics in terms of years of overall teaching experience. Figure 3 shows total years of teaching experience in the compulsory schooling sector. This includes time spent teaching in all forms of schooling, including English-medium.

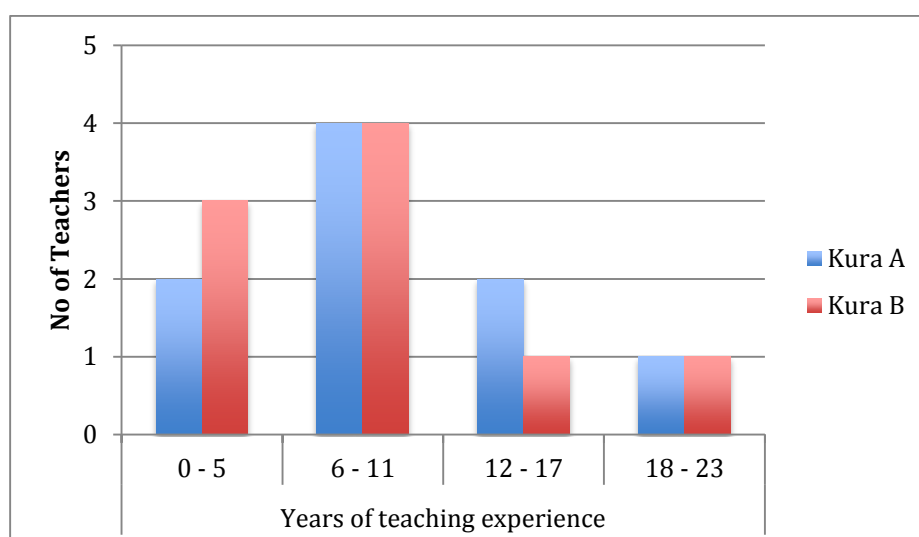


Figure 3. Total years of teaching experience

It is not unusual in Māori-medium schools to have a relatively inexperienced teaching workforce (Murphy et al., 2008). For example, over half of the teachers from *Kura B* were in their first five years of teaching.

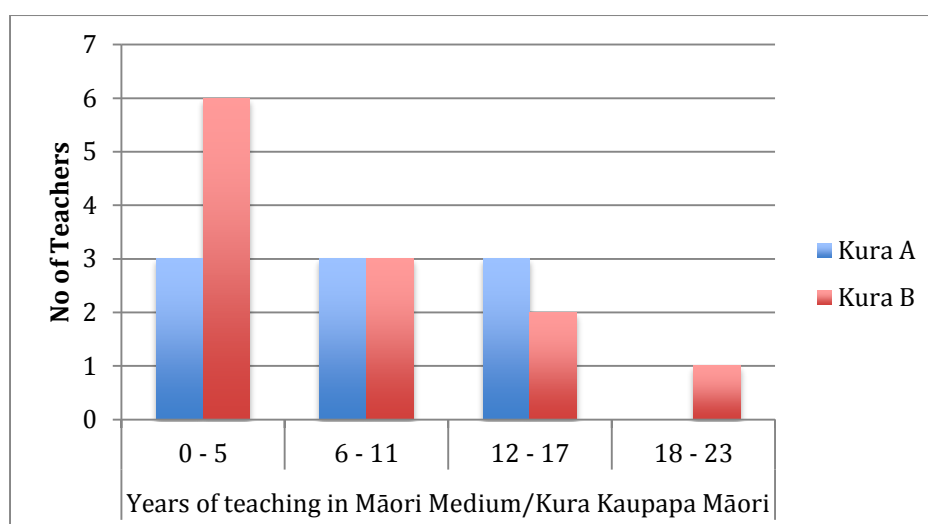


Figure 4. Years of teaching experience in Māori-medium/*kura kaupapa* Māori

A major concern in Māori-medium education generally is that approximately 70% of beginning teachers in Maori-medium schools will leave that workforce in the first three years of their career (compared with an average of 30% in the English-medium sector; Ogilvy, 2012). However, they are not a loss to the profession of teaching. The majority of beginning teachers who leave Māori-medium education move to English mainstream schools to teach in bilingual, immersion units and as general Māori language teachers in secondary schools (Ogilvy, 2012). While there is anecdotal evidence that suggests the lack of resources, the level of fluency of teachers and the political tensions all contribute, more formal research is needed to confirm the factors that cause beginning teachers to exit Māori-medium education.

8.4 Teachers as Mathematical Language Learners

There is a paucity of literature that examines Māori-medium teachers' learning. Therefore, it seemed valuable to investigate how teachers currently teaching in Māori-medium schools concurrently learn the *pāngarau* content and the mathematics register, particularly when most teachers are L1 English speakers.

8.4.1 Teachers as learners of the *pāngarau* lexicon

In this context, not only are students learners of the lexicon, but teachers are as well. For the majority of teachers at *Kura A* and *B* who taught

pāngarau, the first time they encountered the specialised terms was when they started their teaching practice in Māori-medium *kura*—learning on the job, in effect. For a few teachers, the first opportunity they had to participate themselves in *pāngarau* education was during their initial teacher education training (see Figure 5.). This is primarily because this service was not accessible nationally, as had been hoped. Murphy et al. (2008) identified only four initial teacher education programmes that provided immersion programmes that delivered 80% to 100% of the content in *te reo Māori*. These institutions tended to be in large urban areas or were specifically *iwi*-based programmes, explaining why *Kura B* (in a large urban centre), for example, had more teachers who had trained in Māori-medium initial teacher education programmes than *Kura A*. Most teachers at *Kura A* had both their own schooling and their teacher education in the medium of English, even though a number were native speakers of *te reo Māori* (see Figure 5).

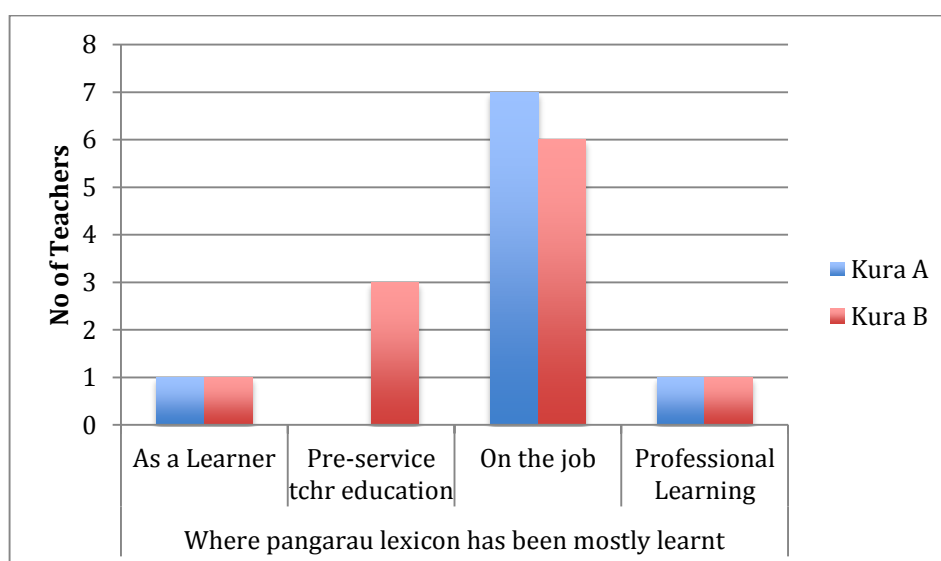


Figure 5. Where teachers learnt *pāngarau* lexicon

In the following sections, teacher responses are coded as KA (*Kura A*) or KB (*Kura B*) and each teacher is given a number; for example, KA T2 refers to Teacher 2 in *Kura A*. Nine teachers from *Kura A* and 10 teachers from *Kura B* participated in the surveys. Direct quotations from teachers have been italicised.

8.4.2 Teacher knowledge of *pāngarau* terms

Given that these teachers were teaching mathematics in *te reo Māori*, it was worth considering how they rated (see Appendix F, Q10 for level descriptors) their knowledge of the newly created standardised *pāngarau* terms at the time of the survey. The ratings were based on the assumption that teachers teaching in Māori-medium taught *pāngarau* in the medium of Māori. Teachers were also asked about particular areas of *pāngarau* in which they found terms difficult to learn and/or remember. Teachers' knowledge of *pāngarau* terms in both *kura* ranged from "basic" to "good" (see Figure 6), although one acknowledged that, while she knew the everyday terms, she had not known initially any of the specialised *te reo Māori* terms for *pāngarau*.

KA. T2. Teaching at Year 1 to 2.

I te timatanga i raru pai ahau, nā te mea kihai au he kupu, engari i tēnei wā kua waea, kua pai (in the beginning, I did not know any of the terms, but now I am familiar with them, I am fine).

The only secondary teacher (who taught Years 11 to 13) in *Kura A* who taught *pāngarau* rated his knowledge as extensive. This is not unexpected, because he had taught *pāngarau* in the medium of Māori at the secondary level for a number of years. Given that secondary teachers teach more abstract mathematics at a higher level, they would need to have a more extensive vocabulary than their junior teacher counterparts. This elaboration of mathematical terms as students move through the grades can be seen in the following quotation from Christensen (2003):

There are 43 different types of number listed in the curriculum document that use the base word "tau" (for example, taukehe—odd number, tau tōraro—negative number, taurahi—scale factor, and so on). If students are introduced to the specialised vocabulary relevant to their level, they will experience less difficulty when further terms are added as they move to higher levels. (p. 35)

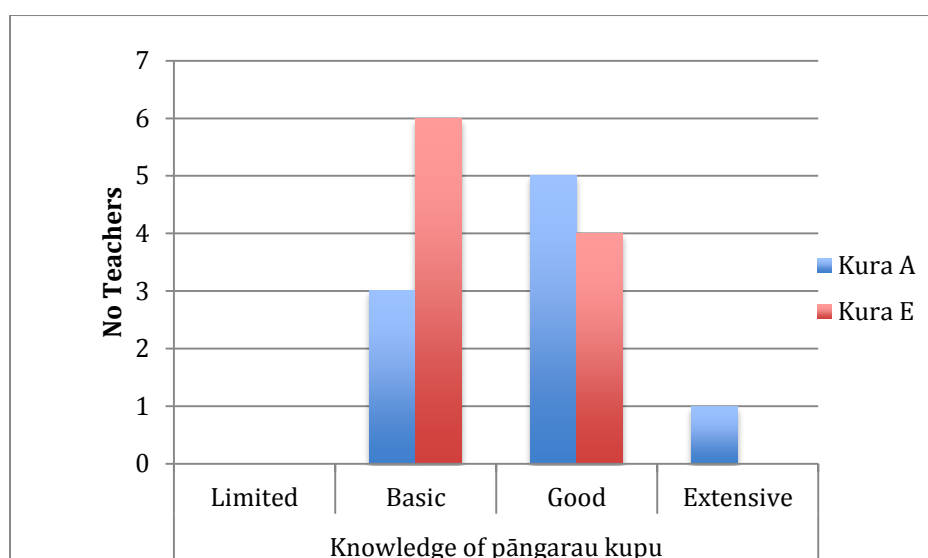


Figure 6. Teachers' self-rating of their knowledge of *pāngarau* terms

8.4.3 Challenging terms, challenging language

The teachers were asked in the questionnaire if there was any mathematics terminology or language they had found challenging to learn or accept and why. As adult L2 learners, the majority of teachers at both *kura* found specific groups of specialised terms challenging to learn. These can be grouped under the following categories. Some of the terms not accepted by teachers are subsequently discussed.

KB. T9. *All the words, especially tauanga* (statistics).

KB. T5. *Terms from the tauanga and taurangi* (algebra) *strands and the names of the stages for the number framework.*

KB. T3. *Yes, the new terms for the strategies.*

KA. T3. KB. T4. KB. T5. *Words from the statistics strand.*

The terms teachers in primary schools generally found most difficult to learn, and perhaps to understand, included conceptual terms from the *tauanga* (statistics) and *taurangi* (algebra) strands, such as *raraunga motukore* (continuous data) and *raraunga rōpū matatini* (multivariate data). These specialised statistics terms are rarely heard or used outside the school domain. Teachers found these sorts of terms provided little if any linguistic clue to their meaning.

KA. T3. *Some words provide no linguistic clues just like the English word "rectangle".*

Teachers sometimes found the terms that labelled concepts or particular techniques and problem-solving strategies difficult. In some cases, this

was academic discourse that teachers may not use directly with children but that would be used by mathematics educators. For example:

KA. T2. *Ngā kupu mō ngā paheko me ngā kupu rautaki* (the words for the operations and strategies).

Some teachers noted that they had difficulty understanding and remembering terms that denote the stages of the number framework underpinning the Poutama Tau Project (Ministry of Education, 2008b), currently used by many schools in Aotearoa/NZ. These newly coined terms include words to describe particular strategies, such as *tikanga paremata* (compensation) and *te wāwāhi whakarearea* (multiplicative partitioning). Other than on the job, the only situations in which teachers are exposed to these terms are in initial teacher education or infrequent professional learning opportunities.

8.5 Strategies to Learn *Pāngarau* Lexicon and Register

As has already been noted, the first time many of the teachers encountered the register and/or the specialised language of *pāngarau* was when they actually started teaching in Māori-medium schools. Teachers were asked to describe the strategies they used to identify the relevant lexicon and to learn the *pāngarau* lexicon “on the job”. This included the teachers who had their own schooling and training in *te reo Māori* because many new terms have since been introduced into the vernacular. Broadly, the strategies teachers have used to learn the new language for teaching *pāngarau* can be grouped around the following common themes:

- Identify key words in planning stage
- Refer to the Ministry of Education resources
- Look for linguistic clues
- Borrow terms directly from English
- In-school learning community
- Regional/national professional learning community.

8.5.1 Identify key terms in planning stage

The most common strategy used by teachers from both *kura* was to identify the key terms either from English or *pāngarau* texts in the lesson

and or unit planning stage. They would then ask a colleague for help if they did not know the equivalent *te reo Māori* term from the English-language reference text or the meaning of *te reo Māori* term from *te reo Māori* text. However, this was not always possible. Sometimes teachers were hampered by the lack of availability of a colleague who was familiar with the corpus of terms and their meanings. In one case, the teacher asked the students themselves or checked with colleagues:

KB. T3. *I ask colleagues and students.*

KA. T6. *I check with the tumuaki first and then ask some of my colleagues.*

Although asking students may sound odd, if a teacher has recently moved into teaching a new level of *pāngarau*, it may well be that students have had more recent interactions with what is being taught and so would be more familiar with the relevant terms.

8.5.2 Refer to the Ministry of Education resources

Teachers also referred to the glossaries and other resources that accompanied the development and revision of *pāngarau* curricula.

KB. T4. *I look up the pāngarau dictionary, ask around or look at the back of the Marautanga (Māori-medium mathematics curriculum).*

The glossaries developed for the curriculum eventually evolved into dictionaries, which were distributed free to all schools. Once the *pāngarau* dictionary (see Te Tāhuhu o te Mātauranga, 2004) became available in 2004, teachers frequently used it to look up terms. According to teachers in both schools, the dictionary is very useful as it gives the origin of the mathematics term and its general meaning, as well as an example of how to use the term. However, some teachers admitted to not knowing there was a specialised dictionary, which was somewhat surprising, to say the least.

KB. T5. *I find an English-medium resource and try and find the meaning that way.*

In a few instances, new teachers in *Kura A* were discouraged from using a few standard terms from the dictionary that were different from the standard terms of the school, for example, using *torutanga* for a third rather than the standardised term *hautoru* (*torutanga* is the term used in

the Māori version of the bible that was translated in the 1860s). While publicly they endeavoured to use the terms that had gained currency in their school, they admitted to occasionally reverting to terms they had learnt from previous schooling contexts:

KA, T6: *Ka whai ake i ngā kupu a te tumuaki, engari ētahi wā ka mahi āku* (I follow the terms that the principal uses, but sometimes I use my own words).

KA, T1: *I tend to use the ones (terms) I have grown up with and or learnt from previous teaching or the words commonly used by the school.*

8.5.3 Look for linguistic clues

In *Kura A*, more so than in *Kura B*, when teachers encountered terms they did not know, they sometimes looked for linguistic clues in the word itself:

KA, T4. *I try and look for linguistic clues. It is also a good strategy to teach children—particularly the numbers.*

Sometimes the teachers used linguistic clues to identify the root word, or broke words down into manageable phrases:

KA, T5. *I show them a tapa whā—four-edged shape, and the word tapa—edge, whā—four.*

The realisation that teachers could use this strategy was some vindication for decisions made in the 1980s with regard to the creation of new terms. A codification consideration, which guided the development of the corpus of terms, was that the meaning of the terms should be more transparent to the learner. These comments are consistent with Christensen's (2003) research that suggested that "where teachers understood the Māori origin and mathematical context of the word, acquisition was greatly assisted" (p. 35).

However, such a conclusion is tempered by the teachers' responses in this study. While the transparency of meaning in some of the terms aided teachers' and students' learning and mathematical thinking, there was a sense that not all terms were helpful in this way, and that this strategy was limited by a number of variables. Effectiveness of the strategy could be contingent on the age and *te reo Māori* fluency of the teacher. For example, most teachers who are reasonably fluent when confronted with words like *tau whakanui* may be able to use its etymological make-up,

knowing it has something to do with the “number that enlarges an artefact”. Irrespective of their level of language proficiency, teachers noted that some terms provided minimal clues:

KA. T13. *Te kupu tikanga paremata* (compensation strategy). *Kāore he hononga i waenganui i te kupu me tona tikanga* (There is no linguistic link between the word and its meaning).

When I first heard the words *tikanga paremata*, which were used to mean “compensation strategy”, I too could not see the connection. In everyday communicative *te reo Māori*, *paremata* has been borrowed from English to mean “parliament”—a transliteration. In discussion with the Poutama Tau group (a number were also members of Te Oho Pāngarau) who coined these terms, we all agreed that the traditional meaning of the word “payment or return” had long fallen out of use in everyday *te reo Māori*. Accordingly, the term *paremata* now has two completely different meanings—the everyday meaning and the specialised *pāngarau* meaning. This exemplifies one of the challenges in learning the specialised register: the more familiar everyday meaning of a term often differs from the specialised mathematical meaning.

8.5.4 Borrow terms directly from English

In the absence of knowing the standardised term, teachers admitted that in some cases they simply invented the word, generally by transliterating the term, which is probably more acceptable in their particular contexts of *te reo Māori* than code switching:

KA.T5. *Sometimes I just made up the word.*

This, though, was the exception rather than the rule. Transliterating is not a codification practice that has much support among the younger generation of *te reo Māori* speakers. They seem to support the purist linguistic ideology promoted by Te Taura Whiri (Māori Language Commission) in the 1980s as the orthodox linguistic practice, and consequently the norm. This is one of the great ironies of the elaboration process of *te reo Māori*. Transliterating was once the linguistic norm among native speakers in order to cope with the introduction of new lexicon in the vernacular, but as language shifts have occurred, and power

relationships have changed, so too have beliefs about borrowing and or coining new terms.

8.5.5 In-school learning community

Teachers also used the learning opportunities provided in school with their fellow colleagues to learn new terms and to discuss and practice the register. Both *kura* utilised staff professional learning meetings to discuss mathematics topics and to identify key vocabulary. *Kura A* set targets for the use of mathematics vocabulary and discussed how to talk about particular mathematics concepts, thus practising the *pāngarau* register (Principal, *Kura A*). The principal posed particular mathematics problems for staff to solve in their meetings. As a *kura*, they focused on specific strands and associated register, from Year 1 to senior school (Principal, *Kura A*). In *Kura B*, two *pāngarau* curriculum leaders have responsibility for Years 1 to 6 and 7 to 9 respectively. They used their weekly professional development staff meetings to share resources, plan and discuss the language required.

This shows that the construction of the mathematics register is not simply the work of Te Ohu Pāngarau. Registers are also constructed and then learnt by a community of users (teachers) interactively “using” the register.

8.5.6 Regional/national professional learning community

Teachers noted that there was a lack of opportunity nationally (and, of course, internationally) for Māori-medium teachers to participate in external professional learning opportunities in the medium of Māori:

KA. T2. We initially had PD for pāngarau until [the facilitator] left. At that point because there was no facilitator for our area, most of us have missed out on subsequent workshops as they were only available for one teacher per school.

KA. T4. I have never been involved in pāngarau professional development for the reo.

8.6 Acceptance of Linguistic Norms

Teachers at both *kura* were also asked if there were any standardised mathematics language and/or terms they had accepted more easily than others and why this was the case (see Appendix F):

KA. T3. *If I understand the origins of the word and why it was chosen, I tend to accept words more.*

KB. T4. *When the words are closely related.*

KB. T5. *The terms that I use frequently.*

Teachers were asked whether there were any standardised terms they did not agree with or use. Only *Kura A* had a few standardised terms not used by teachers. These included the terms for multiplication and fractions:

KA. T2. *Ka mahi tonu mātau i te kupu whakarau* (we [the school] still use *whakarau* for multiplication).

KA. T1. *I tend to use the ones (terms) I have grown up with and or learnt from previous teaching or the words commonly used by the school.*

Such behaviour can be attributed to several factors. *Kura A* had a larger group of native or older speakers of Māori, who have grown up using transliterations such as *kaute* (count) and *nama* (number), in comparison with *Kura B*, where all the teachers of *pāngarau* were L2 learners. A number of teachers in *Kura A* also had started teaching *pāngarau* before a standardised corpus of mathematics terms became available. In the 1980s, for example, *whakarau* was initially coined for multiplication and was the most common term in use for a number of years. In recent years, some members of Te Ohu Pāngarau suggested a shift to using *whakarea* because of the linguistic confusion the term *whakarau* could create for students (and teachers) because *rau* also means “a hundred”. Thus, *whakarau* could be interpreted as “make a hundred”. *Rea* also means to multiply and has a number of other non-mathematical meanings (e.g., murmur).

In *Kura A*, some of the terms that were eventually discarded in the standardisation process have become fossilised in the language of the older group of teachers and thus have become difficult to change. While I personally was a long-time user of *whakarau*—and it took some time for me to change—I understood the rationale for the change. Many teachers at *Kura A*, however, were not aware of the rationale, which was based on avoiding possible linguistic confusion, and hence their use of the original term persists.

One teacher from *Kura A*, while acknowledging the need for a standardised curriculum and glossary, raised the issue of *iwi* dialect in classroom use:

KA. T10. *Ki toku whakaaro, me tuhi hoki ngā kupu nō iwi kē* (In my view, we should also use the dialectal terms).

Despite some angst in the late 1980s and early 1990s concerning the standardisation process and the inclusion and exclusion of particular terms, for the most part, the standardised corpus of mathematics terms has become the established norm in these two schools, and probably in most *kura* nationally:

KB. T1. *Kua whakaae ki te nuinga, tata nei te katoa* (I agree with most of them, close to all of them).

One of the reasons for acceptance of the *pāngarau* standardised terms is that, unlike English-medium education, the vast majority of print and electronic *pāngarau* resources are funded by the Ministry of Education, with support from Te Ohu Pāngarau. As a consequence, the standardised terms are always used. Despite the change in the agency primarily charged with the word creation and standardisation of *pāngarau*, the initial norms established primarily by Te Taura Whiri have been maintained. This highlights two major sociolinguistic considerations. First, once a particular sociolinguistic norm has been established in a language community, it is difficult to change. It reveals the power and authority of Te Taura Whiri, which, in the 1980s, was guided by some key native speaker language revivalists with their attendant purist language ideologies. It is questionable whether Te Taura Whiri has the same authority today.

Second, many of the teachers of *pāngarau* are L2 learners and tend to follow the linguistic norms established by Te Taura Whiri in the 1990s. It may be that some terms need to be reconceptualised from time to time, as is currently happening with science vocabulary in *te reo Māori*²² (Te Tāhuhu o te Mātauranga, 2009). This should not be seen as a failure of

²² The *pūtaiao* terminology was initially developed at one meeting between Te Taura Whiri and a European scientist, rather than as a series of iterations involving its ultimate users—the teachers.

the original choices but a reappraisal of the appropriateness of terms after a period of functional use.

8.7 Summary

The language planning goals of the two case study schools in this chapter have often been in conflict with the dominant ideologies and hegemony of the state education system. After a long struggle, one has morphed from within a state English-medium school with an immersion unit into a stand-alone Māori-medium *kura-a-iwi* school. The other, a *kura kaupapa Māori*, was launched as an indigenous community initiative, initially outside the state system. While the histories and situations of the two *kura* are significantly different, they have in common a commitment to the revitalisation and maintenance of *te reo Māori*. They also both exemplify the long struggle of a community to create an alternative schooling option that meets their *whānau* schooling aspirations with a modicum of *whānau* control. These two *kura* are examples of LPP at the micro-level of language planning.

While these two groups represent only a small sample of teachers, and the situation is changing as *kura kaupapa Māori* graduates enter the Māori-medium teaching workforce, empirical (Murphy et al., 2008) and anecdotal evidence suggests they are reasonably typical of the current situation in the teaching of *pāngarau* in Māori-medium schools. The majority of teachers in both schools were themselves educated in the medium of English because Māori-medium education has only become available more recently. One of the consequences of this linguistic situation is that many teachers are developing their fluency and knowledge of the specialised lexicon and specialised register *as they are teaching it*. The effect this has on interactions between teacher and learner is not yet clear. There is a paucity of research nationally and internationally showing the effects on student learning when taught by teachers who are simultaneously developing their fluency in the language of instruction and learning the specialised register.

Teachers in these two case study *kura* have, to some degree, taken on the responsibility of improving their fluency and in learning the new

terminology themselves. They use a variety of strategies to identify the key lexicon to teach particular concepts in the medium of Māori, including asking more experienced and knowledgeable colleagues and using glossaries, dictionaries, and the *pāngarau* resources available. These linguistic resources were not available to teachers in the 1980s. They have only become available over the past 20 years as a component of the wider mathematics education strategy of the state rather than as a component of a specific LPP for *te reo Māori* schooling. This chapter has only examined one side of the problem. It needs to be acknowledged that communicating mathematically involves not only the use of technical terms but also phrases and characteristic modes of arguing that are consistent with the *pāngarau* register. These aspects were not fully considered in this chapter for reasons of scope.

In the absence of any coherent Māori-medium national language plan to support teachers, these two *kura* developed their own localised language plans. One of the features of their language plans is in the form of their own professional learning programmes to deal with particular linguistic challenges presented by the lack of fluency of some of their teachers and the teaching of *pāngarau*.

With a few exceptions, the majority of standardised terms in *pāngarau* are the established norm in these *kura*. The exceptions in *Kura A* are due primarily to the fossilisation of terms in the language by teachers who used particular terms before there was a standardised corpus of terms available.

A recent paper by Trinick, Meaney and Fairhall (2014) draws on some of the data (i.e., the demographic data, and some teacher responses) from this chapter to highlight the issue of mathematics teachers around the world teaching in a language different from the one in which they studied.

The following chapter discusses the issues raised in this and previous chapters in regard to the development of the lexicon to teach mathematics, and the associated issues to do with teaching and learning of *pāngarau*.

Chapter 9. General Discussion of Tensions and Issues

9.1 Introduction

The causes of the tensions highlighted in the previous chapters concerning attempts to reclaim *te reo Māori* as the language of schooling are complex and multifaceted. What is of primary interest to this current study are the issues and tensions that have arisen as a result of this development and implications for *pāngarau* education and *te reo Māori*. In this chapter, the issues arising are discussed from three broad perspectives. The first provides a critique of the macro-sociolinguistic beliefs and ideologies that have influenced the codification and elaboration of the specialised *pāngarau* terms and register at the various levels of LPP. This includes a summary of the principles of lexical development derived from the two influential groups involved in the process that are used to codify and elaborate the lexicon: Te Taura Whiri (government language planning agency) and Te Ohu Pāngarau (*pāngarau* working group). This chapter also examines how the development and implementation of the *pāngarau* lexicon and registers have been impacted on at the three levels of LPP.

The development of new terminology, especially the issue of whether lexication follows the indigenous roots versus the borrowing approach, can be emotive and contentious. Therefore, this chapter includes a discussion of the conflicting language goals of the various groups and agencies directly and indirectly involved in the process.

The second perspective considers how the development of the mathematics register in *te reo Māori* discussed here has involved not just development of the lexicon but also new ways of expressing meaning (Halliday, 1978). Ironically, this may have led to unplanned *te reo Māori* change when one of the goals of the language revitalisation movement was *preservation* of the indigenous language. Consequently, this chapter discusses the possible negative effect on *te reo Māori* and Māori culture of establishing linguistic norms to teach mathematics. As noted, this does not suggest that mathematics is solely responsible for these issues. There are

many other factors to consider. For example, Maclagan, Harlow, King, Keegan and Watson (2004) noted that the phonology (pronunciation) of “everyday” *te reo Māori* is changing because many speakers are frequently (L2) learners of *te reo Māori*. Everyday language use has an influence on language use in the classroom. However, mathematics (and literacy) are high-stakes subjects in schools and have received considerably more state support, in comparison with the other curriculum areas, to deliberately embed sociolinguistic norms in the form of the *pāngarau* register.

The third perspective discussed in this chapter focuses on the capacity of teachers in the case study schools many of whom are L2 learners of *te reo Māori* to teach in the medium of the recently elaborated language, and the pedagogical implications for learning and teaching. While the combined number of teachers in the two case study schools is small ($n=19$), I suggest these teachers are reasonably representative of the Māori-medium profession as a whole.

9.2 Corpus Planning: *Pāngarau* Post-1980s

As noted in Chapter 4, the norm for the development of *te reo Māori* terms, from the initial contact period with Europeans in the 1800s up to the 1980s, was to adopt loanwords predominantly from English by social interaction. This changed substantially in 1987 with the establishment of Te Taura Whiri, when they became the agency primarily responsible for formally developing the corpus of terms needed to modify the language, including acting as the standardising agency. Te Taura Whiri abandoned the strategy used earlier for over 150 years to adopt new words into the vernacular; namely borrowing and transliterating words (loanwords). Expanding the meaning of traditional Māori words to reflect new ideas became the norm post-1980s (Harlow, 1993). This is because, over time, Māori attitudes (including those of members of Te Taura Whiri) to loanwords have varied as different ideologies gained ascendancy and the status of *te reo Māori* changed. In the 1980s, when Te Taura Whiri was created, *te reo Māori* was no longer in a position of dominance in the community—as it had been prior to the 1940s. Accordingly, there was much greater reluctance to continue the use of transliteration, given the

perceived threat at that time to ongoing *te reo Māori* use. These beliefs and attitudes about coining new terms were also adopted by the Ohu Pāngarau group and had a significant influence on the strategies used to create new *pāngarau* terms. Following is a summary of the approaches used to develop new terms drawing on the narrative of the key informants (as well as my own experiences) and the earlier work of Barton et al., (1998). Teachers' views of the new standardised terms are considered also.

9.2.1 Linguistic strategies used to create terms post-1980s

As an outcome of the meetings between Te Taura Whiri and Te Ohu Pāngarau in 1990, and the publication of the 1991 glossary (see Ministry of Education, 1991), the norms were established for future stages of evolution of the *pāngarau* lexicon. With the exception of a very few terms, such as *hēneti* (cent), all the newly created *pāngarau* terms are not loanwords (transliterations) but recently coined terms (see Te Tāhuhu o te Mātauranga, 2004, 2010). The various techniques used for creating (coining) new terminology for *pāngarau* in the modern era included:

- Adding prefixes and suffixes: The common prefix in Māori is *whaka*, a causative prefix that is now used extensively in *pāngarau*. For example, *rūnā* means to “pare down” or “reduce”. The prefixed form, *whakarūnā*, was adopted for “simplify” as in “simplify the fraction 4/12” (becomes 1/3). Two common suffixes in *te reo Māori* are the passive suffix and the nominal suffix; for example, *wehe* meaning divide can become *wehea* (passive), meaning to be divided and *wehenga*, meaning division (nominal).
- Changing the meaning of existing words: The drift of word meanings over time is common in most languages, but in the case of *te reo Māori*, this process has occurred very rapidly because the language had to be elaborated very quickly to support the functional use in schools. (The issue of rapid language change is discussed further below.) Some words have become much more specific than their original meanings. For example, *tango* has many meanings variously related to “take up, take hold of, acquire”, but now with teachers in

Māori-medium education, its mathematics meaning—to “take away or subtract”—dominates.

- Functional shift: This is a process whereby an existing word comes to be used with another grammatical function; for example, when a noun is formed from an adjective. *Koeko* traditionally had only an adjectival meaning, “tapering to a point”. In the development of the *pāngarau* lexicon, it was transformed into a noun to mean “cone” or “pyramid”, as in *koeko tapawhā rite*, meaning triangular pyramid. Contemporary *te reo Māori* purists have often condemned such developments (Reedy, 2000), although they have occurred throughout the history of *te reo Māori*, and ironically in some cases, may even reclaim the original sense of a word.
- Calquing: This is when words are created from the translations of the common or original meaning of the mathematical word used in English. For example, the word “chord” is a straight line joining two points on the circumference of a circle and comes from the Greek word (chordê) for a piece of animal gut used as a string. The Māori word for “string” is *aho*. So the Māori-medium mathematics term for chord is now *aho*.
- Compounding existing words: This is to form new words by combining or putting together old words. The root words may be run together with no separation; for example, *hangarite* as a modern mathematics term is used to mean “symmetrical”. *Hanga*, can mean “shape”, and *rite*, meaning “alike or “corresponding”. Alternatively, terms may be left as separate words, such as *tatau māwhitiwhiti*, meaning māwhitiwhiti to “skip” and tatau to “count”.
- Resurrection of old words sometimes with slightly modified meanings: An example of this is *ine*, a traditional Māori word for “measure” that had fallen out of use for over 100 years. It has since been resurrected in *pāngarau* to replace the transliteration *meha*, meaning to measure, that had been used for about 100 years, and is now the standard term.
- Circumlocution: This is when the mathematics term created is an explanation rather than just a single word. It is sometimes used when it is linguistically too difficult to create a single word. For example, *tau*

e whakareatia ana means, “the number that is multiplied” and is the *pāngarau* term for “multiplicand” and *tau whakarea* for “multiplier”. For example, 2 (multiplicand) x 3 (multiplier) = 6. Syntactically, this becomes *rua* (2) *whakareatia ki te toru* (3) *ka* 6. This is opposite to English because of the function of the *ki* in the syntactic structure. *Ki* is a preposition meaning “by means of, with (of instrument)”. This can be very confusing for students learning bilingually. (This is discussed further on.)

- Reduplication: This is a process in which the root or stem of a word (or part of it) is repeated exactly or with a slight change. For example, *tāruarua* means “recurring”, repetitive, as in a *tauirā tāruarua*, meaning “repetitive pattern”, *tauirā* “pattern” + *tāruarua* “repeating”.
- Creation of metaphors: This strategy is closely related to calquing and a number of the other strategies above. For example, *kauwhata* is now the word for “graph”. The traditional meaning of this term, “a stage or frame for hanging fish to dry” has been extended metaphorically by considering a graph as a frame on which to “hang” statistical data, parallel to the traditional meaning (see Pimm, 1987, for an in-depth discussion on the use of metaphor in mathematics).

9.3 Corpus Planning: Schooling, Conflicting Language Goals

The corpus development process chosen, and described above, was not simply technocratic, but was also based on certain linguistic and educational beliefs and ideologies held by key groups, such as Te Taura Whiri and Te Ohu Pāngarau, on how to create the new terms. There was a strong belief among the Māori-medium mathematics education community in the 1980s, even before the introduction of the state’s compulsory curriculum, in the need to standardise mathematics terms, particularly for teaching mathematics in secondary schools. The goal was to facilitate consistency and common interpretation of mathematics terms for use across the country and to raise the status of *te reo Māori* as the medium of instruction. Local word varieties such as those used initially by Kura A and B were eliminated with the implicit intention of making the standardised form the preferred form in the belief this was the best strategy for supporting learning pāngarau nationally. The two case study schools in

this study evolved to address language revitalisation goals in the communities they represented. One of their goals was the preservation of their local dialect. As this illustrates, standardisation is an ideological process.

However, as noted in Chapter 7, while on one level schools advocated for the preservation of their own linguistic identity and their own *tino rangatira* (authority), teachers appreciated the fact that terms were available and they were able to make sense of them by looking for linguistic clues. This was a key goal of the *pāngarau* educators (Te Ohu Pāngarau) to minimise the linguistic burden for teachers. Second, teachers from the two case study schools stated that they relied on the *pāngarau* dictionary to help them construct their lessons—ironically the dictionary is an outcome of lexical standardisation. Teachers also appreciated the state produced *pāngarau* resources. Therefore, the conflicting language goals were not simply between schools as representatives of their tribes and the standardising agencies, but also internal to the micro-level of schools themselves.

9.3.1 Standardisation versus dialect loyalty

At the community level, many *iwi* continue to hold strong views that newly developed curriculum areas such as mathematics should reflect their own dialects, including the desire for dialect-specific *pāngarau* terms used in schools in their tribal area (Meaney et al., 2012). While the differences between *te reo Māori* dialects are not great, *iwi* tend to be very sensitive to any initiative that smacks of standardisation (Harlow, 2005). Dialects traditionally have been one of the significant identity markers for Māori. This was exemplified in a recent report into the state of *te reo Māori*, in which one of the recommendations was to: “Sustain dialects of the *iwi*. Dialects provide the foundation to individual identity and maintain the depth and richness of tribal knowledge” (Te Paepae Motuhake, 2011 p. 23).

While members of Te Ohu Pāngarau support the preservation of *te reo Māori* dialects (Informants 1 and 2), there is also acknowledgement from the *pāngarau* community that standardisation has made it easier to teach

pāngarau in schools. Additionally, the written language is easier to monitor, and therefore more easily regulated by agencies such as the Ministry of Education in the form of financial support for terminology development, resource development and professional learning support for teachers. *Te reo pāngarau* is the language of the high-stakes secondary school assessments and examinations, and it is the language of the national curriculum. With the exception of a few terms that differ from *kura* to *kura*, the standardised corpus of terms is purposefully taught and promoted in most Māori-medium mathematics learning situations including Kura A and B.

According to Haugen (1983), these are important matters to do with “function”. He argued that a norm must be selected and accepted because neither codification nor elaboration is likely to proceed very far if there is not agreement on some kind of model to act as the norm. This thesis also argues that the outcome of the process has been the development of a *register* as distinct from a *dialect*.

In my experiences as a member of Te Oho Pāngarau team that has progressed standardisation of the terminology, *iwi* and *hapū* are not swayed by these academic arguments. What is of primary concern to *iwi* is the revitalisation of *te reo Māori*, in particular, their own dialect, which reflects their tribal identity as a community of speakers. Although the issue comes up periodically, particularly when *te reo Māori* issues come to the fore nationally, the development of a dialect-specific *pāngarau* lexicon and/or register has not eventuated. This can be partly attributed to the weakness of *te reo Māori* in many homes and communities, which may have affected the vitality of the dialect. It was evident in the case study schools that a few dialectical and non-standardised terms were in daily use. When they were used, it was generally by the older speakers, who started teaching mathematics in the medium of Māori in the era before terms were standardised. The tension then is that for successful elaboration of *te reo Māori*, it has to be responsive to the universal needs of language efficiency, while at the same time trying to accommodate the particular demands of localising ideologies such as dialects—no easy task.

9.3.2 Language purism versus pragmatism

While on one level schools may not have universally supported standardisation, they have supported, for the most part, the strategy to create terms from native stock. The desire to purge *te reo Māori* of the phonologically adapted terms during the corpus development process was closely linked to the “language purism” ideology espoused by Te Taura Whiri throughout the 1980s and 1990s and generally supported by teachers, particularly L2 speakers. In Aotearoa/NZ, purism became important during the time of lexical modernisation and language elaboration in the modern era, providing a criterion for the choice of new lexicon and codification (Harlow, 1993). Purism has been defined in several different ways, but often involves cultural fundamentalism and a return to (or a search for) linguistic authenticity (Annamalai, 1979). It often takes the form of removing from the language elements (usually lexical) that appear to be foreign or corrupt or lacking in true authenticity in the linguistic culture in question (Annamalai, 1979; Jernudd & Shapiro, 1989). The following definition by Annamalai (1979) has been widely used to describe this process:

Purism is the opening of the native sources and closure of the non-native sources for the enrichment of the language. . . . The factors that lead to purism may be, theoretically, internal or external to the language . . . More important than any structural consideration is the attitude of speakers toward native and non-native elements . . . The attitude is determined by socio-cultural, political and historical factors, which are external to language. There are certain conditions some or all of which must be present for the puristic regulations to emerge in any language [such as when the] social order is undergoing change with power relations redefined. (pp. 3–5)

Critics of linguistic purism, such as Schiffman (1998), argue that puristic movements in linguistic cultures come and go—they wax and wane. They are often very unscientific, relying on dubious ideas about what is “native” and what is not, and, as a result, many aspects of the movement get “fudged” because of ignorance of the history/etymology of various words, or because it becomes too complicated to remain consistent (Schiffman, 1998). It remains to be seen whether this argument will apply to *te reo Māori* in the future.

Annamalai (1979) suggested that the situation of accepting non-native vocabulary, as was the case with *te reo Māori*, during a certain period of time (pre-1980s in the case of Aotearoa/NZ), then rejecting it at a later time (post-1980s), arises under certain social conditions, and is often the corollary to policy development of a language planning agency. When Te Taura Whiri was set up in 1987 as an outcome of the Māori Language Act, this is precisely what materialised. In a gathering of Pasifika mathematics language developers and educators to discuss mathematics lexicon development to be adopted by each Pasifika state, including Aotearoa/NZ, Kāretu (1991), the then Te Taura Whiri commissioner, affirmed that it was a conscious decision on the part of Te Taura Whiri to avoid the use of borrowings, instead looking to classical sources for roots, or alternatively, in order to be descriptive. He admitted that this approach quite often led to a lengthy word or expression, and to avoid that, the word was shortened by dropping vowels and consonants. Ironically, the new shortened words have often since proved confusing to native speakers of the language (Kāretu, 1991, p. 21).

One of the other ironies of the purging of transliterations is that the seminal Māori language learning texts developed in the 1970s, considered classics by many—including one written by Kāretu himself (1974)—freely used loanwords. Purism then does not necessarily make languages “purer”, nor does it always favour the “older form”. Indeed, in the case of other curriculum areas such as *pūtaiao* (science), it has led to the creation of completely new terms (neologisms) rather than the revitalisation of old terms—as was the practice for mathematics.

Pragmatically, it would have been more efficient to transliterate (borrow) the terms from English, as was the practice previously. However, led primarily by Te Taura Whiri and Te Ohu Pāngarau, instead of borrowing terms, it was decided to create new terms by changing the meaning and or function of existing Māori language terms—all of which takes time and negotiation. Corpus development work in the 1980s was concerned to either resurrect *te reo Māori* terms that had fallen out of use, or expand the meaning of *te reo Māori* terms in use in everyday language by giving them an explicit mathematical meaning. Some of the key informants interviewed

for this study in Chapter 7 were of the view that, by resurrecting traditional terms, the language was being re-enriched. The choice of this codification norm conflicts with a major concern in lexical development internationally, that is, to ensure intertranslatability between standard languages (Liddicoat, 2005). As a consequence, many languages, such as Hawaiian, a sister Polynesian language to *te reo Māori*, have instead made use of international terminology in areas such as mathematics but given them a Hawaiianised sound and spelling (Hinton & Hale, 2001).

The merit of resurrecting old terms is supported by Liddicoat (2005), who presented a counter-argument to the one above when he stated that “even though intertranslatability may seem desirable for many reasons, the process of developing a modernised lexicon privileges particular (European) systems of knowledge over others” (p. 1,000). But not only is the vocabulary of languages culture specific, so, too, as Mühlhäusler (2003) asserted, along with many others (e.g., Halliday, 2001), grammars are “fossilised experience. Each grammar can be seen as a repository of past experience, as the outcome of a very long process of adaptation to specific environmental conditions” (p. 120).

Another factor which influenced the decision to resurrect and then give traditional terms a mathematical meaning was the attitude of some mainstream teachers. I recall there was a perception in English mathematics education in Aotearoa/NZ during the early corpus development work in the 1980s that it was simply not possible to develop a legitimate *pāngarau* register—a challenge familiar to other indigenous groups adapting their languages to teach Western mathematics (see Schindler & Davison, 1985 for issues to do with adapting the Navajo language). So the adoption of puristic beliefs was in some way a reaction to the lack of support of, or outright hostility by, a range of groups at efforts to elaborate *te reo Māori* and to the thought of teaching mathematics in the medium of Māori. A key reason, therefore, for the “puristic” ideologies that underpin the elaboration of the mathematics language is primarily non-linguistic and more to do with the status of *te reo Māori* and people’s attitudes to its status during the period of codification of the linguistic norms (Harlow, 1993):

To preserve the language as a living means of communication entails preserving it in opposition to and distinct from English. If in order to fit Māori for the Māori world, we borrow from English, this looks like a sort of admission of defeat, an admission that in fact Māori is not capable of handling new ideas and topics with its own resources. (p. 129)

Ironically, all languages, including English, do this most, if not all, of the time. Jernudd and Shapiro (1989) argued that the language purism movement is a social phenomenon involving a collective, so in order to gain traction there have to be like-minded others. The Ohu Pāngarau members interviewed for this thesis study do not recall any explicit discussion amongst themselves about the need to purge *te reo Māori* of all transliterations.

During the 1990s period of corpus development, groups such as Te Ohu Pāngarau were obviously, in retrospect, strongly guided and influenced by the practices and puristic beliefs of Te Taura Whiri. Since Te Taura Whiri had the *mana* (prestige) and provided language models for emulation, the majority of teachers simply followed in rejecting the apparently “non-native” items (Annamalai, 1979). Many involved in the education sector such as teachers in Kura Aand B were L2 speakers of *te reo Māori* and were sensitive to frequent criticism by language elites, such as Te Taura Whiri, about the standard of *te reo Māori* spoken by adult learners such as teachers (see Kāretu, 1991; Reedy, 2000; Te Paepae Motuhake, 2011 for criticism). This is because, outside of the home, the school is still the primary *te reo Māori* revitalising domain, and for some families the only domain. Also, the late 1980s and early 1990s was a period of political turmoil and tension in education caused by the neo-liberal transformations discussed in Chapter 5, and groups such as the Rūnanga Nui o Ngā Kura Kaupapa Māori (*kura kaupapa* governing organisation) asserting their newly acquired linguistic rights in the form of *Te Aho Matua*. I recall vividly that at that time, Te Ohu Pāngarau was highly conscious of criticisms from within education from both Māori and Pākehā alike at attempts to develop Māori-medium curricula. By supporting the purging of the majority of transliterations, Te Ohu Pāngarau thus attempted to present some form of authenticity to *te reo Māori* community in their own work.

9.3.3 Language authenticity versus elaboration

One of the Ohu Pangarau informants argued for the “authenticity” of *te reo Māori* to be maintained. This view was also held by several older Māori speakers who believed that the newer ways of speaking were inferior to the older ways (Reedy, 2000). Language change from this view was seen as language degeneration (Coupland, 2003). Authenticity of language competence is derived from the idea that the performance of language learners should correspond in some way to the performance of an ideal “native speaker” (McDonald, Badger, & Dasli, 2006), and is thus closely connected to the ideas of “linguistic purism”.

However, linguists do not always support the shift towards more authentic language. This particular language ideology, in tandem with puristic ideologies, can “freeze” language at a particular juncture, thus jeopardising language revitalisation efforts, such as coining new terms. Additionally, linguists contend that correct grammatical usage does not always appear to be necessary for successful communication to take place (Canale & Swain, 1980). When “non-native” speakers engage in conversations with each other they tend to use similar communication strategies, such as “approximation”, “word coinage”, “circumlocution”, “translation” and “language switching” in order to make themselves understood by each other (Jourdain, 2000; Ludwig, 1982).

Because there will continue to be new developments and changes in mathematics education, there will be a constant need for new words—borrowed, coined, derived, or otherwise formed—simply because new pedagogical and mathematics ideas need new words. It is difficult to confirm whether the strategy of only coining (calquing) new terms will be continued long term or not. Establishing the norms of codification, via either puristic or pragmatic approaches, is an ideological process, and the creation of a standardised corpus of terms and the development of a modernised *pāngarau* register both have linguistic, cultural and political consequences—for language communities and the language itself.

9.3.4 Symbiosis or cultural change?

The creation of a standardised corpus of terms, along with the development of a modernised *pāngarau* register, inevitably also has linguistic and cultural consequences for the language communities and for the language itself. The introduction of new vocabulary was not the only aspect of the development of a *pāngarau* register. The development of registers such as that for Māori-medium mathematics have also involved new styles of meaning (i.e., representations and graphs), new ways to tell stories (i.e., mathematical number stories), new syntactic structures (i.e., for multiplication), and combining existing grammatical features into new combinations. One of the ways that meaning is constructed in mathematics in English is through logical connectives—conjunctions that join ideas together that have a logical relationship (Meaney, Trinick, & Fairhall, 2007). The types of relationships indicated by these expressions include time and space, enumeration and exemplification, amplification and contrast, interference and summation, cause and effect, and so on. Māori language has an abundance of logical connectors, but terms such as “relations” vary to suit different contexts, unlike English, in which the term “relationship” can be used across a range of contexts. In *te reo Māori*, the term “relation” can be translated as either *whanaunga* or *pānga*. *Whanaunga* implies some human relationship. Therefore, *whānau* terms are considered inappropriate to describe “relationships between mathematical ideas and objects” (Meaney et al., 2012, p. 88). If used so, it will cause a meaning change to the term and thus a change to the *wairua* or “spiritual essence” (my translation) of the language (Meaney et al., 2012).

This suggests that the development of a mathematics register based on Western mathematics for indigenous languages will likely cause changes in the indigenous language and culture. While not aimed specifically at teachers of *pāngarau*, native speakers of *te reo Māori* have been the most vociferous in voicing their concerns at the change to the *wairua* of the language. The *wairua* (spirit) of a language is inextricably linked to cultural considerations and relates to the statement by Rangihau (as cited in Browne, 2005), “Te reo Māori as I see it, is a *reo wairua*, a spiritual

language” (p. 27). The *wairua* of a language seems to relate also to the issue of *whakapapa* (genealogy). Royal (1998, p. 3) suggests that *whakapapa* is the “skeletal backbone to our [Māori] knowledge system” (p. 3).

Another outcome of the standardisation process that may have caused cultural and linguistic change—and is something that is common in Western mathematics—is decontextualisation. For example, the traditional Māori compass points are not located regularly around the horizon as in the magnetic compass. There are also many different directional terms from different iwi that refer to the same direction (compass point). Directional terms are very localised, sometimes related to certain tribal traditions and often oriented to prevailing winds, celestial phenomena or the local geographic landscape. The word *kapehu* (compass) implies certain conventions in Western mathematical practices with a needle that points to magnetic north. By decontextualising the directional points, it is possible that the tribal traditions that gave rise to the various direction terms are also lost. Changing the language used to describe the experience, whether it is a change in natural language, such as English to *te reo Māori*—or a change in register within a language—will inevitably have an impact on how that experience is described and therefore what is valued in that experience.

9.3.5 Understanding the new terms

The biggest critics of the new language have tended to be the reo Māori speaking public. It is the older fluent speakers, who find it difficult to understand the “new” language used by the younger generation including teachers, which incorporates the “new” vocabulary (Reedy, 2000). In relation to *pāngarau*, part of the problem lies in the disparity between their understanding of the traditional use of the word and its new mathematical meaning(s). Words have changed their grammatical function, for example, changing from transitive verbs to nouns. Reedy (2000) argued that the semantic shift of many traditional day-to-day Māori terms adapted for use in school subjects such as mathematics is often too great, and therefore jarring to the ear for older native speakers. The issue of teachers’ understanding is discussed in Section 9.4.2.

9.3.6 New grammar, new registers: Becoming more like English

One of the ironies facing the revival of the language is that, in order to save *te reo Māori*, it would seem the language has had to become more like English. Developing mathematics in the indigenous language along the lines described in previous chapters, despite the emphasis on “authentic” vocabulary, can still become an unwitting vehicle for transforming the phonology and syntax of a language. While research has shown that the pronunciation of *te reo Māori* has been greatly influenced by English (Keegan, King, Harlow, Maclagan, & Watson, 2008), there is growing evidence to suggest that the syntax of *te reo Māori* generally is also changing to be more like English (Harlow, 2001). A type of hybrid language is evolving—a grammatical mixture of Māori and English. This view is supported by Informant 3, who contended that in many cases the way *te reo Māori* is being articulated in the mathematics classroom approximates the structure of English. He cited examples of the syntactic structure for algorithms, in which students and teachers follow the English-language structure rather than a more traditional Māori grammatical form. The English-language active form characterises the speech of many contemporary speakers of Māori, a form many speakers are now more familiar with. In short, as a consequence of revitalising the language, structurally *te reo Māori* is becoming more like English. For Māori, the concern is linked to the issue of cultural assimilation and maintenance of ethnic identity. For many Māori, *te reo Māori* is an important symbol of their ethnic identity: “it’s what makes us Māori distinct from European!”

9.4 Levels of Language Planning and Policy (LPP)

As noted in Chapter 2, there are generally considered to be three levels of LPP—the macro, meso and micro (Kaplan & Baldauf, 1997). At the macro-level this may take the form of a government level language policy (or the absence of one). Meso-level may include the development of language curricula for schools and micro-level, a community group working together to revive their language. The following section examines how the development and implementation of the *pāngarau* lexicon and register have been impacted on at the three levels of LPP.

9.4.1 Macro-level of LPP: Statutes and agencies

In the wider political context, the macro-level planning involving “top-down” national government policies (e.g., the 1987 Māori Language Act and the work of Te Taura Whiri) have had a considerable influence on corpus development nationally, including the language of schooling. As previously discussed, the desire during the early corpus development process post-1980s to resurrect traditional terms or expand the meanings of terms in daily use, and to purge *te reo Māori* of transliterations, was closely linked to the “language purism” ideology held by Te Taura Whiri, whose language beliefs were influenced by the subordinate status of *te reo Māori* in the 1980s.

With the creation of Te Taura Whiri, the authority for creating and standardising terms became the state’s responsibility. While some of this authority came from state legislation and from the *mana* (prestige) of Te Taura Whiri itself, its subsequent withdrawal from the lexicon modernising process has raised issues, including who now has the authority to create new terms.

In the current absence of a centrally agreed body with authority to define and plan codification and elaboration of *te reo Māori* for teaching and learning, responsibility has defaulted to the Ministry of Education and, by extension, to their contractors and the development teams responsible for each individual Māori-medium education initiative. Fortunately for *pāngarau* education, this work has been devolved, for the most part, to one or more individuals from the original development group (Te Ohu Pāngarau), thus maintaining some consistency in the codification process, at least for the time being.

9.4.2 Meso-level of LPP: Māori-medium schooling

At the meso-level of LPP, it was not until a combination of macro-level political agitation (e.g., the findings of the Waitangi Tribunal, 1986, 2010) and micro-level grassroots education initiatives outside the state system came to the fore that the state was compelled to support Māori-medium education nationally. State support has always been conditional upon what

may be in the best interest of the state rather than in the best interest of Māori-medium education per se.

Māori-medium schooling, including elaboration of the language for schooling, has been directly influenced by political imperatives underpinning English-medium schooling and policy concerned with Māori student underachievement. For example, the goal of various government initiatives, such as the numeracy strategy and related curriculum development, and the more recent development of national standards, has been to improve student achievement in these areas—not necessarily to support a broader goal of language revitalisation. At the meso level of planning, as an outcome of the government's education and numeracy strategy, there was thus a need to significantly expand the corpus of terms required to facilitate the successful implementation of these policies in Māori-medium schooling.

Māori-medium mathematics education has been significantly more resourced than other Māori-medium curriculum areas because of the role of mathematics as a government educational priority area and also, relatedly, because of its high-stakes positioning. As an outcome of these various education policy initiatives, there has been a considerable corpus expansion, first of *pāngarau* terms and then of the mathematics register, through the development of specialised resources, discussions in communities of practice and functional use in the classroom. This has not been the experience, as yet, of other curriculum areas in Māori-medium education. Only recently has a dictionary been developed for *pūtaiao* (science; Te Tāhuhu o te Mātauranga, 2009); no such development has occurred for other curriculum areas (apart from mathematics). There is no official government strategy for curriculum areas, other than numeracy and literacy. Most of the lexical development for other curriculum areas occurred in a very short period in 1996 as an outcome of the work of Te Taura Whiri, generally independent of the users (schools and teachers). English-medium literacy and numeracy have been the key curriculum focus areas of the past 20 years and, by default, so have Māori-medium literacy and numeracy.

9.4.1 Micro-level LPP: Case study kura

Kura A and B are examples of LPP at the micro-level. Kura such as Kura A and B then have represented an interface between macro-level and meso- and micro-level language planning. The micro, “bottom-up” level of planning included language policies and plans of collective (e.g., *Te Aho Matua* policy) and individual Māori-medium schools and attempts by teachers, many of whom are L2 learners, to learn new specialised lexicons and discourses. As was discussed in Section 8.5, both kura developed in-school learning opportunities to develop their knowledge of *pāngarau* including workshops to discuss specific terms. At the individual level, most teachers admitted they were learning the specialised terms as they taught, but had developed a range of coping mechanisms, such as identifying key words in the planning stage, referring to the Ministry of Education resources and looking for linguistic clues (see Sections 8.5.1–8.5.6).

The top down policies have also included such things as the development of curricula which have acted as de facto LPP. At the political level, the Ministry of Education’s support for the development of *pāngarau* register, resources and so on can be attributed in part to the strict *te reo Māori*-only policy of *Te Aho Matua*.

The histories of the two case study kura are diverse as they sought to respond to their local needs and contexts. Kura A started life as a grassroots initiative, initially outside the state system. Kura B evolved from within the state system and through the force of its own convictions emerged as a standalone school. What is common to both is the key role of the principals and teachers in assuming agency as they struggled to establish their kura. Gradually they both gained a level of recognition and funding—in turn, impacting on macro-level education policy, for example, the Ministry of Education was much more accommodating of difference in the 2008 revision of the *pāngarau* curriculum. This can be attributed largely to the successes of the schools such as the two case study schools and *Te Aho Matua* policy discussed previously.

9.5 Stages of LPP Development: Lexication and Register

The development of modern *pāngarau* language may be viewed as consisting of a number of periods or stages, in each of which at least one language planning goal has been sought. Drawing on the Kaplan and Baldauf (2003) LPP framework (see Chapter 2), development of the *pāngarau* language lexicon and register has progressed through the following LPP stages.

Language Planning Stages	Date/Group	Text/Publication
Informal (unplanned) LPP. Ad hoc creation of terms at the local level. LPP goal to meet daily and weekly lexicon needs. Formal: establishment Education Act 1989.	1978 Ruatoki school becomes first bilingual school. Early 1980s, individuals and groups of teachers with support from local community create terms. 1985 first <i>kura kaupapa Māori</i> established; provided the impetus to accelerate development.	Localised word lists created. Rikihana (1988), Barton & Cleave (1989) <i>pāngarau</i> glossaries. 1989 Education Amendment Act provides formal recognition for <i>kura kaupapa Māori</i> .
Formulation: setting the goals of the policy (status planning).	Te Taura Whiri established 1987 along with re-established Te Puni Kōkiri.	1987 Māori Language Act
Codification. Goal to establish principles of codification; i.e., no loanwords; terms that are related mathematically should be related linguistically. The strategy of introducing new terms was to be only by coining new terms.	1991 Te Taura Whiri and Te Ohu Pāngarau working party establish their own codification principles.	<i>He Muka</i> 1988–1995. <i>He Muka</i> is the quarterly newsletter of the commission, incorporating the commission's events, new terminology coined by the commission and other important issues relating to the Māori language. This publication continues on to the present, but many of the orthographic conventions, principles of codification were established in earlier publications.
Standardisation. Goal to create a basic corpus of <i>pāngarau</i> terms.	1991 Te Taura Whiri in collaboration with Te Ohu Pāngarau working party meet to standardise terms.	Ministry of Education and Te Taura Whiri agreed to standardise list of terms (Ministry of Education, 1991). 1996 Toitū te Reo—Māori language strategic plan
Fine-tuning. Additional maths terms were added and or deleted according to the above principles and include the following stages:		
Elaboration. Goal was to further expand and standardise vocabulary to enable the language to function as the language of instruction in higher levels of schooling.	1993 First <i>wharekura</i> established at Hoani Waititi Marae. Curriculum mid-1990s, Te Taura Whiri, Ministry of Education, Te Ohu Pāngarau & teachers. 2008 revision of curriculum Ministry of Education and Te Ohu Pāngarau	Expansion of glossary of terms (Ministry of Education, 1995). Development of Māori-medium mathematics curriculum (Te Tāhuhu o te Mātauranga, 1996). Development Poutama Tau resources 2003–2011. Revised <i>pāngarau</i> curriculum (Te Tāhuhu o te Mātauranga, 2008).

Language Planning Stages	Date/Group	Text/Publication
Cultivation. Goal was to advance the status of the language. Intergenerational language initiative.	Ministry of Education and, Te Ohu Pāngarau working group. Withdrawal of Te Taura Whiri from corpus work in education.	Publication of <i>pāngarau</i> dictionary (Te Tāhuhu o te Mātauranga, 2004). Publication of <i>pāngarau</i> dictionary 2nd edition (Te Tāhuhu o te Mātauranga, 2010). Māori Language Strategy (Te Puni Kōkiri, 2003).
Implementation and intellectualisation goal (educational spread).	Curriculum policy. Professional learning initiatives and policy. Development of limited number of Māori-medium initial teacher education programmes (discussed in Chapter 10).	Poutama Tau initiative 2002–2012.

9.6 Unplanned *Te Reo Māori* in Education

As discussed in Chapter 5, to date, the government (or its agency, the Ministry of Education) does not have an explicit plan for Māori-medium education for the compulsory schooling sector. Māori language education policy has tended to be subsumed within the much broader field of Māori education policy. Not until 1999 was the first Māori education strategy launched, with three goals in mind: a primary focus on raising Māori student achievement in mainstream education, supporting greater Māori involvement and authority in education, and supporting the growth of high-quality *kaupapa Māori* education (see Ministry of Education, 1999). What this policy meant in regard to supporting *te reo Māori* in practice was not clear. It was not until 2006 that the Ministry of Education began the process of redeveloping the initial 1999 Māori education strategy, to be called *Ka Hikitia*. The result was a policy framework (*Ka Hikitia*) that sought to address Māori achievement and success in general education (Ministry of Education, 2008a). However, in my view, this policy document is light on policy direction for *te reo Māori* language planning for schooling.

In late 2013, an updated version of *Ka Hikitia*, *Ka Hikitia—Accelerating Success 2013–2017*, was finally launched by the Ministry of Education (Ministry of Education, 2013b). This policy now contains a specific Māori language-in-education strategy: *Tau Mai Te Reo* (Ministry of Education, 2013b). While this development is a considerable advancement on previous Māori in education policies, it is too soon to judge its effectiveness and is, anyway, probably 30 years too late. Ideally, such a

policy should have been in place when bilingual schooling first emerged in the 1970s and early 1980s to guide its development.

9.7 Pedagogical Implications

As noted in Chapter 8, the teacher workforce for Kura A and B has been drawn predominately from the pool of L2 learners of *te reo Māori*. While this is not necessarily a negative in itself, the interviews with teachers showed that many teachers were simultaneously required to learn the specialised and communicative language as they learnt the craft of teaching—a great enough challenge for proficient speakers. Similarly, many students who attend Māori-medium schools are L2 learners. Complicating the issue further is that the use of the modernised *pāngarau* register is largely restricted to the Māori-medium schooling domain; it is relatively new and is still evolving rapidly as new mathematics education initiatives are introduced to the sector. This sociolinguistic situation has pedagogical implications for learning and teaching of *pāngarau* going forward, although this will require further research beyond the scope of this thesis.

9.7.1 Implications of the teachers' language for the learner

A considerable body of research in mathematics education supports the premise that learning the mathematics register may be requisite to understanding the specific content of mathematics (Cummins, 2000; Pimm, 1987). Studies show that the language of mathematics is complex and differs from everyday language, and thus can make learning mathematics challenging, even more so for students who are L2 learners. Kura A and B are confronted by a situation in which the language of the home and community for many of their students is their L1 (English) and the language of schooling their L2 (*te reo Māori*). By extension, the dilemma for kura such as Kura A who have a policy which promotes the separation of languages is whether or not to allow code switching in order to support learning, probably in the stronger language for many students, that is, English—a strategy supported by international research into models of bilingual education (see, Cummins, 2007). Again, this is an area for further research and discussion.

9.7.2 Implications for the teacher

There are a number of major pedagogical challenges confronting teachers such as those in Kura A and B. The first is the personal knowledge and language proficiency of the teacher in the language of *pāngarau*. International research in mathematics education has highlighted the key role of teachers in modelling the language that is needed to support students' acquisition of mathematics language (O'Halloran, 2000). While specialised *pāngarau* terms are slowly infiltrating domains such as the media (Meaney et al., 2012), and Māori-medium initial education programmes are now available, use of the *pāngarau* register is still very much restricted to the compulsory schooling domain (i.e., Years 1–13). Consequently, in the Aotearoa/NZ context, the teachers' *pāngarau* language is the predominant language model for students' learning of *pāngarau*. However, as exemplified in the case study schools examined in Chapter 8, many teachers are L2 learners and learning the specialised language of mathematics as they teach. While not burdened with the same linguistic overload, native speakers are frequently learning the specialised language as they teach. The *pāngarau* register is being acquired primarily by constant *use* in classroom practice.

Knowledge of the specialised *pāngarau* register by itself is not sufficient. Teachers and professional educators also require the language associated with discussing and investigating complex mathematics education issues and topics in order to advance their knowledge. The forum in which the mathematics education register and language is often learnt is in initial teacher education and professional learning programmes. However, the revitalising efforts of *te reo Māori* schooling over the past 30 years have not been matched by comparable efforts from initial teacher education institutes.

Initial teacher education as a model of higher education plays a key role in the intellectualisation of a language, and as noted in Chapter 2 is an important dimension in language development (Garvin, 1973), including that of *te reo Māori*. It involves the development of new linguistic resources for discussing and disseminating conceptual material at high

levels of abstraction (Liddicoat & Bryant, 2002) that supports the teaching of mathematics conceptually in primary and secondary schools.

9.8 Summary

Evidence reported in previous chapters has shown that the development of both overt and covert language plans in Aotearoa/NZ has tended to reflect the political and economic goals of the dominant Pākehā (European) group rather than (what could be construed) as their linguistic or cultural concerns about *te reo Māori* per se. The wider agendas of the Pākehā majority in social, educational and economic policy have been the priority, and thus have predetermined language policy for Māori, including *te reo Māori* in education.

It was not until the mid-1980s that significant political agitation at the macro political level by Māori and the subsequent release of the Waitangi Tribunal in 1986 compelled the state to formalise LPP in statute for *te reo Māori* in the form of the Māori Language Act 1987 and the creation of Te Taura Whiri. Most of the formal LPP work, such as status and corpus development and standardisation, was then devolved to Te Taura Whiri.

Since that time, there has been much in the way of unplanned language policy and planning at the macro-level that has impacted on the meso and micro-levels in education. The goal of most government policies has been to raise Māori student achievement in English-medium education. While this is a worthy goal, the lack of a general language planning framework for Māori-medium education has meant that often linguistic initiatives have been created by Māori-medium educators as add-ons to policy initially developed for national (English-medium) education.

Despite the many complex political and linguistic challenges, the *pāngarau* register, particularly the terminology, has undergone significant codification/standardisation and elaboration in the past 20 years or so. The elaboration of *te reo Māori* to teach subjects such as mathematics has been a dynamic between the opposing forces of standardisation and dialect, and conservation and innovation. Preliminary research shows that the newly created terms and the register are, in part, effecting further

changes in *te reo Māori*. In the modern era, concerns about language change have become more urgent in response to the language becoming endangered and to the subordinate position of power and authority of Māori. Further research is needed to identify more substantially where the language is changing, and whether this change is desirable or not according to the perspectives of both linguistic purists and pragmatists.

Because the natural intergenerational transmission of *te reo Māori* has been essentially disrupted for decades, *te reo Māori* is not the L1 for many teachers and learners in Māori-medium education, and the school is often the only domain within which the specialised vocabulary and register is heard. Unfortunately, there has been no explicit language plan and or policy for Māori-medium teacher education to address this situation as yet.

Chapter 10. Conclusion and Key Findings

10.1 Introduction

This chapter addresses the research question overall, which is, “What are the key factors that have impacted on the development of the mathematics register for Māori-medium schooling and *te reo Māori* generally, and the issues and tensions, and teaching and learning implications?”

The chapter summarises and discusses the key findings from previous chapters with particular focus on LPP in education issues that have impacted on the development of the modernised lexicon and elaborated register to support the teaching of *pāngarau*. These issues include the impact of the various linguistic ideologies on lexical development, the interface between the macro, meso and micro-levels of LPP, and the role of mainstream educational policies as de facto LPP in determining educational priorities for Māori-medium schooling.

This concluding chapter also briefly considers researcher positioning and the strengths and weaknesses of the research process undertaken in this thesis.

10.2 The Role of LPP in Supporting Mathematics Education

As a mathematics educator, and despite my involvement in many aspects of what can be construed as language planning and policy, it would be fair to say I did not know a lot about the theoretical and conceptual perspectives of LPP prior to this research. I now understand that LPP has two mutually interrelated aspects: the linguistic and the sociolinguistic. The first is concerned with the development of the lexicon and register (i.e., the language to facilitate teaching and learning); the second concerns the status and role of Māori-medium education and the language of schooling in the wider macro political, economic and social context within which this development is situated.

With regard to the first aspect, I became directly involved in LPP through the elaboration of *te reo Māori*, primarily in the creation and codification of the new *pāngarau* terms (although I did not necessarily know I was

involved in codification at the time). Often, when I am facilitating *pāngarau* workshops now, particular terms we created in the 1990s have come up for discussion. I often reflect on the stories and why we chose a particular term (etymology) over others to give a mathematical meaning. Over time, these memories will fade, which is why it has been important to capture the narrative now for posterity and to inform future developments. For example, why did the group representing *pāngarau* education, Te Ohu Pāngarau, of which I was a member, reject as undesirable the practice of borrowing words from English in favour of expanding the meaning of traditional *te reo Māori* terms? The reality was that we were heavily influenced by the politics of the time and the *mana* (prestige) of the individuals at that time who made up the agency charged with this work, Te Taura Whiri.

The significance of this study is that it addresses a gap in the literature by investigating the development of Māori-medium mathematics (*pāngarau*) from a sociolinguistic perspective—namely, various levels of language planning. As noted, internationally, a number of indigenous groups are expanding and elaborating their indigenous languages to facilitate the teaching of Western mathematics, often in a struggle to simultaneously address wider language revitalisation efforts (Meaney et al., 2012). Such a development has implications for the indigenous language and culture. For example, the various ideologies that impacted on Māori-medium education corpus development work in the 1980s to the 1990s and their influence on codification of the *pāngarau* lexicon were rarely explicit to many of us involved in that work at the time. That is why, as a mathematics educator, I chose an LPP methodology and framework to reach a better understanding of the sociolinguistic issues and implications for mathematics education and *te reo Māori*. The findings of this study may in turn help groups involved directly and indirectly in similar developments to know what these implications are and perhaps how to address them.

Much of the research in LPP to date has focused on the macro-level (Kaplan & Baldauf, 2003). In order for LPP to be successful, particularly for language revitalisation such as that of *te reo Māori*, it needs to extend down through the system, including to the micro-level of schooling.

However, the quantity of research focusing on the interconnectedness between the meso (institutional) and micro (community and or individual school) levels of LPP is light. What this study highlights is that effective macro LPP can also support *pāngarau* education at the national and local levels and vice versa.

It has to be acknowledged that Māori-medium education is extremely diverse and is located in highly contested politicised spaces, with a range of sector interests and ideologies. Consequently, a unified LPP for the whole sector would be difficult to achieve. It is to be hoped, however, that studies such as this will provide some evidence to support the need for the development of a comprehensive language plan and policy to benefit Māori-medium education and thus the aspirations of generations of *te reo Māori* revivalists.

Although research on students who do not have the language of instruction as their L1 in mathematics classrooms has been an area of interest since the 1980s, there has been minimal research on the issues faced by teachers. Yet, this is the current situation in Aotearoa/NZ—many teachers in the Māori-medium schooling context are teaching in a language that is not their L1 and in which they may not be fluent (May & Hill, 2005; Rau, 2004). This thesis investigated the implications for learning and teaching of *pāngarau*.

10.3 Limitations and Strengths of This Research

I approached this research primarily from the perspective of my own life and professional experiences. This raises questions, therefore, of potential issues of bias and validity. Critics of interpretivist field research based primarily on qualitative data such as this thesis, question the ability of interpretivist research to replicate observations (reliability) or to obtain correct answers or correct impressions of the phenomenon under study (Cohen et al., 2003; Kirk & Miller, 1986). For example, the development of themes around the analyses of the key informants' narratives could be considered to have been led by my a priori interests, a perhaps unavoidable consequence, given my central involvement in these developments.

Other criticisms of interpretivist research concern the reactive effects of the researcher's presence on the situation being studied and the selective perception or bias on his or her part. Any group that is studied is altered to some degree by the very presence of the researcher. Therefore, any data I collected could be somewhat skewed and are, accordingly, influenced by what is sometimes referred to in the literature as the 'researcher effect' (Mitchell & Jolley, 2007). However, kaupapa Māori approaches call for a researcher to have developed positive relationships with their co-participants with real links to the area being researched (Smith, 2005). I have had a long working relationship with the two case study schools and their principals. Although there have been staff changes, I have worked for a number of years with most of the teachers. In fact, some are graduates of my mathematics education programme. It is possible, therefore, that this relationship caused them to answer the interviews swayed by the nature of our relationships.

Another potential limitation of this study is that aspects of it are retrospective. Although there is some documentary evidence dating back to the 1990s that can confirm the views outlined here (Barton et al., 1998), the study necessarily had to rely on the memory of key informants (including myself) of some events that happened 20 to 30 years ago.

Narrative analyses require an in-depth engagement with, and understanding of, the informants' experience. As a result, there is a possible blurring of interpretive boundaries between the analyst (myself) and the research participant (at times, also myself). Therefore, the analyst (myself) can play too strong an interpretivist role without sufficient links back to empirical data because some of the narrative is based, at times, on the researcher's own experiences (Atkinson, 1997).

However, although a perceived weakness of interpretivist research includes the notion that it is invariably subjective and personal (Stake, 2010), Cohen et al. (2003) have argued that subjectivity is not a failing but something to be reduced or eliminated, by using such strategies as triangulation. Triangulation strategies for this study included three types: data (narratives of key informants, semi-structured interviews with

principals and surveys with teachers), theoretical (two epistemological frameworks used, LPP and SFL), and investigator triangulation. For example, as there was only one researcher in this study, to ensure validity of interviews, the technique of “member validation”, in which the key informants and participants were given a copy of the interview to provide feedback, was used (Schaffir & Stebbins, 1991).

Relatedly, in the process of researching the key topic, I had multiple roles. At times, I was the narrator and/or participant in some of the narrative of the key informants. I was simultaneously the researcher. It was difficult to separate these roles at times, particularly when I was an active participant in the narrative myself. Although I have not led all the major *pāngarau* initiatives, I have been significantly involved in most if not all of the major developments in some capacity. Additionally, I have been an active researcher in Māori-medium mathematics education, primarily because of my passion and commitment in the area.

However, this can be seen as a strength of this study. I have had first hand experience, and thus a good understanding of the holistic picture of the development of the lexicon and register from various levels of LPP now that I understand the discipline of LPP. Thus my own experiences have been a rich source of information about a multitude of Māori-medium education LPP activities that may not have been available to less involved researchers. Narrative inquiry revealed information that is not easily discerned from other research methodologies such as quantitative approaches to these issues. It provided a glimpse of the whole picture rather than a finite set of statistical facts. It supported me as the researcher and as an active participant to make sense of the actions, events and ideologies associated with the development of the *pāngarau* language to support *te reo Māori* revival.

10.4 Conclusion

The first major conclusion of this thesis is that the story of the development of the specialised Māori-medium mathematics language (lexicon and register) is synonymous in many aspects with the story of *te*

reo Māori. The health of these two is inextricably linked in today's modern technological society.

This thesis has explored the development of the Māori-medium mathematics (*pāngarau*) lexicon and register within Aotearoa/NZ over the past 30 years. In so doing, it has highlighted not only accomplishments but also the tensions and difficulties involved in the wider (re) vernacularisation of an indigenous language via schooling. These tensions/difficulties include:

- Linguistic purism versus pragmatism,
- Bottom-up versus top-down planning,
- Te Taura Whiri versus Ministry of Education,
- Indigenous versus national-mainstream education,
- Micro-level LPP versus macro,
- Developing the register, and
- Implications for learning and teaching *pāngarau*.

10.4.1 Linguistic purism versus pragmatism

Ideologies in support of linguistic purism, at least with respect to corpus development, have predominated in the (re) development of registers within Māori-medium education, as evidenced in the *pāngarau* curriculum. This has led, in turn, to a number of potential contradictions. For example, the preoccupation with avoiding transliterations in the development of curriculum vocabulary has led to an increasing disjuncture between older native speakers (who continue to use transliterations extensively) and younger, L2 learners schooled in Māori-medium education. At the same time, this focus on authenticity in the area of vocabulary has masked significant *te reo Māori* change towards English-language norms in grammar among L2 learners involved in Māori-medium schooling (both teachers and students). While this outcome is understandable, the key question is, is it desirable?

The lack of intertranslatability between *te reo Māori* and English at the higher levels of mathematics study could be problematic for the learner. One of the key challenges facing Māori-medium graduates aspiring to

higher levels of education is that pure mathematics is taught only in the medium of English in Aotearoa/NZ. Thus, in order to cope, they need to know the specialised mathematics terms in English as well. Pragmatically, it would have been more useful for these students to have been taught mathematics using transliterated terms as is the custom in a number of other countries, thus making the meaning more transparent and presumably making it easier to switch between languages (this is yet to be fully tested).

10.4.2 Bottom-up versus top-down language planning

The (re) vernacularisation of *te reo Māori* over the past 30 years has exhibited a complex combination of both bottom-up and top-down language planning. Early lexical developments were framed within local grassroots initiatives driven largely by local schools and their communities, which sometimes centred on the maintenance of their tribal dialects. In urban areas, in particular, these initiatives were frequently driven by teachers themselves, motivated by the need to improve Māori student outcomes and/or to support macro-level language revitalisation efforts. This led to an early proliferation of locally distinctive terms for curriculum areas such as *pāngarau*. However, with the ongoing development of Māori-medium education, and particularly its extension to secondary school level, there has been a growing pressure for standardisation, led by key state agencies such as Te Taura Whiri and the Ministry of Education (Te Tāhuhu o te Mātauranga), as well as key stakeholder groups such as Te Ohu Pāngarau. While considerable standardisation has occurred and continues to occur, these tensions between standardisation and regional variation remain.

10.4.3 Te Taura Whiri versus Ministry of Education

Since the 1990s, the authority of the language planning agency Te Taura Whiri has waned in the education sector as it has shifted its modest resources to focus on community language revitalisation initiatives. Indeed, it is questionable whether the current Te Taura Whiri membership carries the language authority it had in the 1990s. However, linguistic purism has remained the dominant language ideology in Aotearoa/NZ for

the creation of new *pāngarau* terms, exemplifying that once linguistic norms are established by language elites such as Te Taura Whiri, they are difficult to change.

Much of the recent lexication work for *pāngarau* has been taken up by the Ministry of Education and its various contractors, often represented by members of Te Ohu Pāngarau. Therefore, there is currently no one agency managing corpus development across all domains of schooling. This is particularly so in tertiary education. In the absence of a coherent national language plan for Māori language in education, much of the work continues to be ad hoc and unplanned. As a consequence, the development has not been as robust as it possibly could have been—for example, the issue of teacher supply for Māori-medium schools remains a constant key issue that has not yet been sufficiently addressed.

10.4.4 Micro-level LPP versus macro

Historically in this country, decisions regarding which language should be taught in schools were almost exclusively directed by various Ministers of Education and macro-level government agencies policies both overt and covert. The principal goals of the state in this regard were to assimilate and then integrate Māori into European civilisation. This changed substantially in the 1980s when Māori communities concerned with the endangered state of the language used their own agency to initiate Māori-medium schooling for themselves. The principal goals were to revitalise the language in their communities and to provide a legitimate pathway of education. Ignoring Māori linguistic rights, the state initially resisted micro-level language revitalising efforts often resulting in schools such as Kura A having to exist in conditions not acceptable in mainstream education contexts. In response to political pressure from Māori, immersion schooling eventually became state funded. However, significant state controls accompanied state funding including the requirement to follow state curricula such as mathematics/*pāngarau*. In order to cope with the linguistic demands of teaching *pāngarau*, both Kura A and B developed localised LPP activities to support micro implementation of macro policy demands. In these contexts, the macro and the micro are now

simultaneously at work, but it's an uneasy relationship as the next section shows.

10.4.5 Indigenous versus “national–mainstream” education

The approach taken to develop the *pāngarau* curriculum highlights clearly the tensions between the distinctive needs and priorities of minority indigenous language education (Māori-medium) developments and those of majority “national” (English-medium) education. These include the ongoing tendency of state agencies to frame initiatives in terms of mainstream education in the first instance, assuming that these will naturally “translate” to the indigenous language education context. Contrary to this, proponents of Māori-medium education have argued, to some degree successfully, that developments such as curricula must be derived from their own educational goals and practices, including, centrally, the commitment to indigenous language revitalisation via schooling. Nonetheless, the development of the *pāngarau* curriculum suggests that these processes remain the subject of intense negotiation, and sometimes conflict, while also being dependent on the key actors (and agencies) at any given time. This means that such developments remain fragile and easily undone. However, they also highlight just what can be achieved in the ongoing (re) vernacularisation of an indigenous language within education. Over the past 30 years or so, there has been considerable capacity building of Māori in education that have the skills to carry on this work in the absence of a language planning agency such as Te Taura Whiri.

10.4.6 Developing the register

As noted in earlier chapters, in many countries, the mathematics register has been developing incrementally over many years from everyday language and/or by borrowing from other languages. The “mathematics register” refers to the specialised language of mathematics: the words and structures that express mathematical meaning. It is not a language in itself but generally the mathematical use of natural language. “Natural” language is language that has evolved naturally over a long period of time as a means of communication among people. For many decades, *te reo*

Māori was excluded by various overt and covert state and local policies from the language of teaching and learning, thus interrupting the natural evolution of the mathematics register for schooling and teacher education. Therefore, there has had to be a deliberate initiative to develop the registers as opposed to leaving it to natural means.

The natural *te reo Māori* is still only used in restricted domains. Thus, the *pāngarau* register may well be more challenging to learn for students in Māori-medium than in English-medium education contexts. The challenge is even greater for the many students and teachers who are simultaneously learning everyday communicative *te reo Māori* and the academic language of mathematics.

An extra linguistic challenge for those working and learning in the field of mathematics education, such as student teachers and lecturers at the tertiary level, is the mathematics education register. Unlike the *pāngarau* register for schooling, to date, the *pāngarau* education register at the tertiary level has received minimal systematic development.

10.4.7 Implications for learning and teaching *pāngarau*

Research points to the notion that graduating teachers require a functional grasp of both communicative *te reo Māori* and the complex *pāngarau* language in order to teach Māori-medium mathematics effectively up to high levels of abstraction (intellectualisation). In English-medium education, the responsibility for the intellectualisation of the language and the advancement of the discipline of mathematics education has been taken up by initial teacher education institutes and mathematics departments at the tertiary level. In the absence of any language plan or agency that regulates or assumes responsibility for the codification, corpus and status planning at the tertiary level, the intellectualisation of *te reo Māori* for subjects such as mathematics, science and technology has been difficult to implement and develop. Although Māori-medium tertiary institutions are developing, they often lack the capacity to support Māori-medium mathematics education. With so few programmes, the discipline lacks a critical mass of academics with an interest and expertise in mathematics education and *te reo Māori*. As a consequence, teachers,

many of whom are L2 learners, are learning the specialised register on the job. Although this situation will change as graduates from Māori-medium schools enter the teaching profession, it does raise significant pedagogical issues, as highlighted in this thesis.

10.5 Accomplishments in Māori-medium mathematics

Despite these tensions and issues highlighted herein, much has clearly been accomplished over the past 30 years in the development of the field of *pāngarau* education. These positive outcomes include:

- A national curriculum (*pāngarau*) in the medium of Māori has been developed and revised—a first for Māori-medium and Māori.
- A standardised corpus of terms to enable the teaching of mathematics to senior levels of secondary school has emerged over the past 30 years or so where previously none existed. This corpus of terms now appears to be in general use in *pāngarau* education.
- The validation of *te reo Māori* as the medium of instruction has occurred, including for the teaching of mathematics to at least Year 13. This has helped raise the status of Māori-medium schooling.
- A good range of *pāngarau* print and electronic resources have become available to support teaching and learning where previously very few existed.
- Students are able to sit the high-stakes assessment including *pāngarau* in *te reo Māori*.
- A seamless progression exists for children and young people through the schooling sector without considerable linguistic discrimination (as was the previous practice in English-medium contexts).
- Growth (albeit limited) has occurred in the number of *pāngarau* curriculum specialists, professional development specialists and researchers where none existed less than 30 years ago.
- Opportunities have become available to participate in professional learning opportunities and dialogic communities with fellow teacher practitioners.

10.6 Directions for future research

There clearly needs to be further comprehensive work to describe the features of the *pāngarau* register, particularly those features that either support or impinge on learning. This study has adopted the definition of the register advanced by Halliday (1978), and his work in systemic functional linguistics (SFL) (Halliday, 1996). SFL offers tools that may help identify linguistic features unique to *pāngarau* that support student learning. A potential example is the part-whole nature of numbers in *te reo Māori*. A strong understanding of part-whole has been shown to increase understanding of subsequent student work with place value, number concepts, and word problems.

Currently little is known about how students learn the mathematics language and register in Māori-medium education. While one can deduce that the linguistic challenges students face in Māori medium are similar to those in English-medium education, as this thesis has highlighted, still more research in Māori-medium education is needed to confirm this conclusion. Internationally, there is a paucity of research that examines student learning of mathematics in a minority L2 (i.e., the indigenous language is the minority language of the community and the L2 of the students, but the language of schooling) from psychological perspectives (Barwell, 2005). Much of the research to date draws more on sociological, anthropological or socio-political frameworks (Barwell, 2005).

Becoming a teacher happens across a continuum, including the formal part of initial teacher education. However, there remains a scarcity of research into student learning in indigenous initial teacher education, both nationally and internationally, from threatened language groups.

Much of the development to date has focused on the development of the language to facilitate the teaching of *pāngarau* to upper levels of secondary school. However, one of the primary goals of schooling initiatives such as *kura kaupapa Māori* has been the reintroduction of Māori knowledge in the form of mathematical practices (ethnomathematics) into the classroom. This is yet to be truly achieved.

10.7 Final words

While I acknowledge there are several unresolved tensions and issues in Māori-medium education, my personal belief is that the teaching of *pāngarau* has achieved two fundamental goals of Māori-medium schooling. It has supported the revitalisation of the language and it provides educational choice for students and parents. If encouraged to communicate mathematically, students will also learn language that has applicability in everyday communication. Mathematics then also has recursively become the vehicle for learning and enriching *te reo Māori*. Despite criticism of the status given to mathematics and the focus on numeracy as opposed to other learning areas, a good understanding of mathematics is vital in a modern technological society, not least because it broadens career options for graduates of Māori-medium education which in turn raises the status of Māori-medium education.

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Ngā Āpitianga/Appendices

Appendix A.

Situational Features of the Register (Halliday & Hasan, 1989, p. 10.)

Situational Features		
		Examples
<i>Field</i>	The field includes what language is being used to talk about what is happening, for example, the purpose and or the context. The topic of discourse can be specialised/technical.	Talking about science, education, or more specifically language education, mathematics or even everyday situations such as shopping
<i>Mode</i>	The mode includes the role language is playing in the interaction, for example, written, spoken or written to be spoken.	A political speech, a lecture, teachers describing a mathematical concept
<i>Tenor</i>	The tenor refers to the people involved in the communication and the relationships between them, for example, the <i>mana</i> (status) of speakers, the power relations, whether formal/informal, frequent/occasional.	Teacher–student, boss–employee

Appendix B.
Dialects and Registers (Halliday, 1978, p. 35)

Dialect (“dialectal variety”) = variety “according to the user”	Register (“diatypic variety”) = variety “according to the use”
<p>A dialect is:</p> <ul style="list-style-type: none"> • what you speak (habitually) • determined by who you are (socio-region of origin and/or adoption) • expressing diversity of social structure (patterns of social hierarchy) 	<p>A register is:</p> <ul style="list-style-type: none"> • what you are speaking (at the time) • determined by what you are doing (nature of social activity being engaged in) • expressing diversity of social process (social division of labour)
So, in principle, dialects are different ways of saying the same thing and tend to differ in phonetics, phonology, lexicogrammar.	So, in principle, registers are ways of saying different things and tend to differ in semantics (and hence in lexicogrammar, and sometimes in phonology)
<p>Typical instances:</p> <p>Iwi dialects (My example)</p>	<p>Typical instances:</p> <p>Occupational varieties (the teaching and learning of mathematics)</p>

Appendix C.
Situational Characteristics of Registers and Genres (Biber & Conrad, 2009, p. 40)

<p>I. Informants</p> <p>A. Addressor(s) (i.e., speaker or author)</p> <ul style="list-style-type: none"> • Single/plural/institutional/unidentified • Social characteristics: age, education, profession, etc. <p>B. Addressee(s)</p> <ul style="list-style-type: none"> • Single/plural/un-enumerated
<p>II. Relations among informants</p> <p>A. Interactiveness</p> <p>B. Social roles: relative status or power</p> <p>C. Personal relationship, e.g., friends, colleagues, strangers</p> <p>D. Shared knowledge: personal and specialist</p>
<p>III. Channel</p> <p>A. Mode: speech/writing/signing</p> <p>B. Specific medium: permanent: taped/transcribed/printed/handwritten Transient speech: face to face/telephone/radio, etc.</p>
<p>IV. Production circumstances: real time/planned/scripted</p>
<p>V. Setting</p> <p>A. Is time and place of communication shared by informants</p> <p>B. Place of communication: public/private, etc.</p>
<p>VI. Communicative purposes</p> <p>A. General purposes: narrate/report/describe, explain, etc.</p> <p>B. Specific purposes, e.g., summarise information, describe method</p> <p>C. Factuality: factual, opinion, speculative, etc.</p>
<p>VII. Topic</p> <p>A. General topic: domain, e.g., domestic, daily activities, workplace, science, education/academic</p> <p>B. Specific topic</p> <p>C. Social status of person being referred to</p>

Appendix D.**A Summary of Syntactic, Semantic and Pragmatic Features of Mathematics Register (Spanos, Rhodes, Dale, & Crandall, 1988, p. 226–227)**

Syntactic features	Semantic	Pragmatic
1. Comparatives, e.g., greater than	1. Lexical -New technical vocabulary -Natural vocabulary that has different meaning in mathematics -Complex string of words or phrases -Synonymous words and phrases -Symbols and mathematical notation as vocabulary	1. Epistemological -Lack of experience or knowledge -Restricted experience or knowledge -Conflicting experience or knowledge -Contradictory experience or knowledge
2. Prepositions, e.g., divided by		2. Textual -Lack of real-life objects or activities -Lack of natural integration
Passive voice, e.g., when 15 is added to a number	Referential -Articles/premodifiers -Variables	
Reversal errors e.g., a is 5 less than 8 incorrect equation $a = a - 5 = 8$	Vagueness in problems and directions	
Logical connectors if, when...	Similar terms, different functions	

Appendix E.
Summary of research design

Decisions about Research Design	Choice
Research discipline or field	Sociolinguistic—LPP and language rights— <i>te reo Māori</i> should be accorded the same rights and protections English already enjoys in Aotearoa/NZ Historical—structural approach
Epistemological and ontological assumptions	Interpretivist, with particular focus on language in education Research influenced by ideology
Theoretical framework	Third stage of language planning, research from sociolinguistic perspectives/approaches, including linguistic imperialism, language rights and systemic functional linguistics
Research approach	Literature analyses Narrative inquiry (multiple voices & case study)
Ethical considerations	Kaupapa Māori
Data collection strategies	Narratives by key informants Semi-structured interviews
Informants	Te Ohu Pāngarau—three informants Principals and teachers from two Māori-medium <i>kura</i>
Timeline	Study conducted over the course of six years, from 2008 to 2014 Proposal and literature review 2008–2009 Interview Te Ohu Pāngarau informants 2010 Interview principals 2010 Questionnaire for teachers 2010 Write up chapters 2011–2013 Submit final thesis 2014

Appendix F.

Indicative Questions: Te Ohu Pāngarau Informants

The Development of the Māori-medium Mathematics language (Register)

1. When & what has been your involvement in the wider *te reo Māori* revitalisation process? What were some of the issues then and now?
2. What role(s) have you played in the elaboration of *te reo Māori*, in particular the new mathematics terminology? What particular skills did you bring to the role?
3. What was your work at the time and did this influence your involvement and the way you thought about the modernising strategies and processes?
4. What motivated you to participate in the process of modernising/developing the new terminology?
5. What were some of the key criteria and considerations in the development process that influenced or guided you or the group that you were involved with?
6. What were some of the tensions and challenges in this development work?
7. What are your views of the recent standardisation process that has occurred in elaborating *te reo Māori*?
8. On reflection, what do you think about the outcome? In hindsight, what would you have done differently, if at all?

Appendix G.

Teacher Informant Questionnaire

1. Which of the following range of years best describes all your years of teaching experience?

- | | |
|--|--|
| <input type="checkbox"/> 0–5 years teaching experience | <input type="checkbox"/> 6–11 years teaching experience |
| <input type="checkbox"/> 12–17 years teaching experience | <input type="checkbox"/> 18–23 years teaching experience |
| <input type="checkbox"/> 24–29 years teaching experience | <input type="checkbox"/> 30–35 years teaching experience |
| <input type="checkbox"/> 36 years or more, teaching experience | |

2. Which of the following range of years best describes your years of teaching experience in Māori-medium/Kura Kaupapa Māori?

- | | |
|--|--|
| <input type="checkbox"/> 0–5 years teaching experience | <input type="checkbox"/> 6–11 years teaching experience |
| <input type="checkbox"/> 12–17 years teaching experience | <input type="checkbox"/> 18–23 years teaching experience |
| <input type="checkbox"/> 24–29 years teaching experience | <input type="checkbox"/> 30–35 years teaching experience |
| <input type="checkbox"/> 36 years or more, teaching experience | |

3. Choose from the list below the school type that you have taught in previously.

- | | |
|---|--|
| <input type="checkbox"/> Rumaki—Kura tuatahi | <input type="checkbox"/> Kura Kaupapa Māori |
| <input type="checkbox"/> Wharekura | <input type="checkbox"/> Mainstream Primary School |
| <input type="checkbox"/> Mainstream Intermediate School | <input type="checkbox"/> Mainstream Secondary School |

4. Select your gender.

- ☐ Male ☐ Female

5. Select the age range that you fit into.

- | | |
|--|--|
| <input type="checkbox"/> 18–28 years old | <input type="checkbox"/> 29–39 years old |
| <input type="checkbox"/> 40–49 years old | <input type="checkbox"/> 50–61 years old |

6. Which of the following year groups do you currently teach *pāngarau* to?

- ☐ Year 1 ☐ Year 2 ☐ Year 3
☐ Year 4 ☐ Year 5 ☐ Year 6
☐ Year 7 ☐ Year 8 ☐ Year 9
☐ Year 10 ☐ Year 11 ☐ Year 12
☐ Year 13

7. Which of the following year groups have you taught *pāngarau* to?

- ☐ Year 1 ☐ Year 2 ☐ Year 3
☐ Year 4 ☐ Year 5 ☐ Year 6
☐ Year 7 ☐ Year 8 ☐ Year 9
☐ Year 10 ☐ Year 11 ☐ Year 12
☐ Year 13

8. Where have you learnt most of the *pāngarau* terminology?

- ☐ As a learner at kura ☐ Pre-service teacher education
☐ On the job ☐ Professional learning, i.e., workshops, conferences, gaining a qualification

9. Have you been involved in the development of the standardised terminology? If yes, in what way?

- ☐ No ☐ Yes

10. How would you rate your **knowledge** of *pāngarau* kupu at Years 1–8 if you are a kura tuatahi teacher, or Years 9–13 if you are a wharekura teacher?

<input type="checkbox"/> Limited	<input type="checkbox"/> Basic	<input type="checkbox"/> Good	<input type="checkbox"/> Extensive
I know the everyday kupu such as numbers to 100, the time terms	I know and use the commonly occurring kupu their meaning(s) and function in <i>pāngarau</i>	I know and use most of the kupu, their meaning(s) and function in <i>pāngarau</i>	I know and use all the specialised kupu, their meanings and function in <i>pāngarau</i>

11. What were some of the *pāngarau* kupu you knew before you started teaching in the medium of Māori?

12. Are there any *pāngarau* kupu you found challenging and why? Do they come from a particular strand or concept area?

13. Are there standardised *pāngarau* kupu that you do not agree with and why?
14. Are there standardised *pāngarau* kupu you have easily accepted and why?
15. If you do not know a particular kupu, how do you deal with this issue?
16. Any further comments about the standardised *pāngarau* kupu?